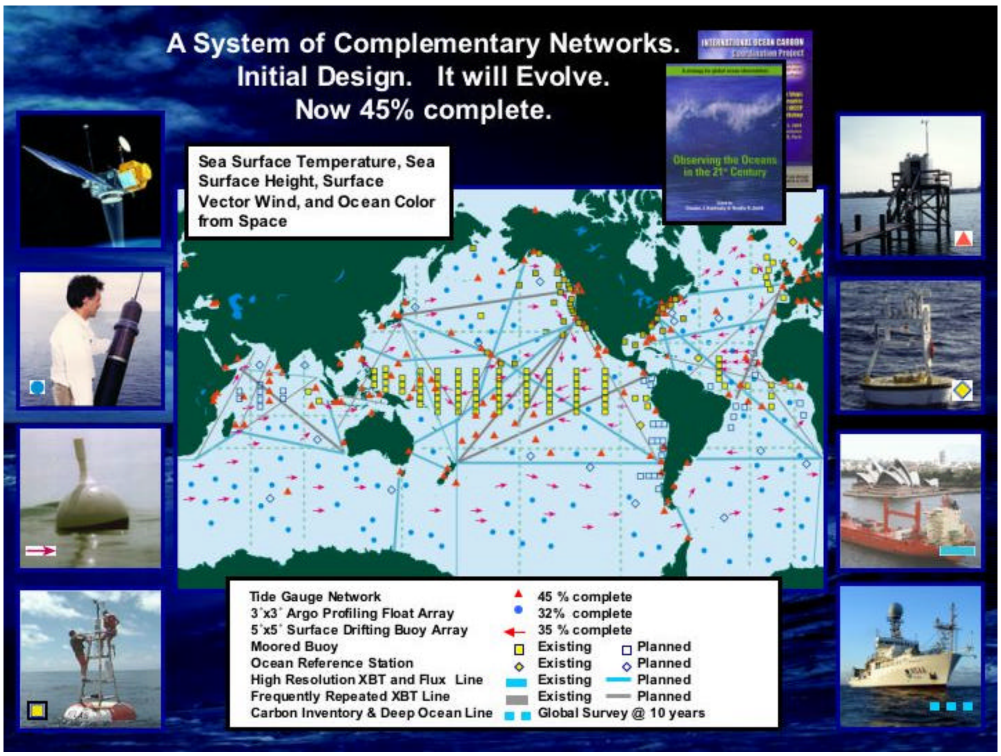
NOAA Climate Observation Program Annual System Review
and the
Climate Observing System Council Annual Meeting

April 13-15, 2004



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Workshop Report

Workshop web site URL: http://www.oco.noaa.gov

May 2004

Copies of this CD may be obtained from:

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All PowerPoint presentations given at the Climate Observation Annual System Review can be accessed by clicking on the file OCOpresentations.doc on this CD. Names are listed in order of presentation as appears on the agenda (Appendix A).

To access posters presented at the Climate Observation Annual System Review, click on the file OCOposters.doc on this CD. Posters are listed in order as noted in the poster abstracts (Appendix B).

To access the final report for the 2nd Annual High-Resolution Marine Meteorology Workshop, click on the file HRMM2esum_final.pdf on this CD.

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Climate Observing System Council Annual Meeting
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Executive Summary

The National Oceanic and Atmospheric Administration's Climate Observation Program was initiated by the Office of Global Programs (OGP) in 1998. The Program is managed through the Office of Climate Observation (OCO), which was established on October 1, 2003 as a center to manage the climate observing system under the auspices of the NOAA Climate Program Office. The goal of the Program is to build and sustain the ocean component of the global climate observing system that will respond to the long term observational requirements of operational forecast centers, international research programs, and major scientific assessments.

In order to advance this goal, the second Annual System Review was held from April 13-15, 2004 in Silver Spring, Maryland. The meeting included discussion of strategic planning, user evaluation and recommendations, partnerships, and key observing system issues.

The three-day meeting was organized as follows:

<u>Tuesday, April 13</u>
Session 1 – Program Overview
Session 2 – Illustrated Posters I
Session 3 – User Evaluation and Recommendations: Operational Centers, Research Programs, Assessments
Session 4 – Illustrated Posters II

<u>Wednesday, April 14</u>
Session 5 – User Evaluation and Recommendations (continued)
Session 6 – Partnerships
Session 7 – Issues

<u>Thursday, April 15</u>
Climate Observing System Council (COSC) Open Session
COSC Executive Session

The second Annual System Review enabled observing system users a chance to 1) provide feedback, and 2) discuss with project managers their requirements and recommendations for system evolution and improvement. User groups were invited to give presentations related to their needs. In addition, representatives from groups partnering with the ocean observing system presented ways that they link to the observing system. Formation of Expert Teams for ocean analysis and the transition of the tropical atmosphere ocean (TAO) array from the Pacific Marine Environmental Laboratory (PMEL) to the National Data Buoy Center (NDBC) were discussed as key issues.

Scientists attending the meeting were invited to prepare posters highlighting their funded projects. PIs provided short introductions and an overview of their research during two Illustrated Poster sessions. An informal evening poster viewing session enabled participants to interact while reviewing posters.

A Thursday morning open discussion session with the COSC and the subsequent COSC executive session focused on the annual ocean report, the annual meeting, the role of the COSC, the TAO transition, and formation of expert teams to conduct ocean analysis.

The first *Annual Report on the State of the Ocean and the Ocean Observing System for Climate* was presented and discussed. Recommendations included incorporating a 4-5 page executive summary for non-scientists and policy makers focused on the state of the ocean and the ocean observing system. Including the executive summary in the NCDC State of the Climate report was suggested to strengthen the ocean-atmosphere connection for climate.

A request was made to integrate more science into next year's Annual System Review. A one-day science workshop could be held jointly with the Annual System Review to provide this forum for scientists and users of their data. Increased international participation should be a goal for future meetings.

The Climate Observing System Council (COSC) serves as a discussion forum to provide advices and make suggestions to the Program based on information received by scientists and users of the data. It was felt that the COSC should discuss the role of research and operations in context for each project.

Lengthy discussion involved moving the tropical moorings as a sustained array to an operational institution. The transition will begin in FY 2005 with NDBC serving as the official caretaker of the array. Concerns were voiced over a climate array moving into a weather service and the commitment given to this array. Indian Ocean research will remain at PMEL while the TAO and PIRATA array will move to NDBC. The goal is to make the transition seamless and transparent with free and open access to all data.

Instituting an expert team or teams was discussed as a way to build an ocean analysis component into the Climate Observation Program to complete an end-to-end ocean observing system and deliver or use the system with maximum impact. Funding schemes were discussed along with the elements to be included in a call for proposals.

Workshop Report

Session 1: Program Overview
Chair: Mike Johnson

Mike Johnson, Director of the Office of Climate Observation (OCO), greeted participants and welcomed them to the Second Annual Climate Observation Program System Review, held at the Holiday Inn in Silver Spring, Maryland. He then introduced the morning session and highlighted upcoming events.

Ken Mooney, Deputy Director of the Office of Global Programs (OGP), welcomed the group and stated that it is key to build an observing system that incorporates data analysis and assimilation and challenged everyone to make good utilization of the data in the best way possible. He congratulated everyone in attendance on their accomplishments over the last year.

The NOAA Climate Program – Implications for Observing Systems
Chet Koblinsky, Director of the NOAA Climate Office and Acting Director of OGP

Chet Koblinsky, stated that the observing system has come far since the first meeting five years ago in San Raphael. A dream had been articulated and the team is pulling it all together. Kudos were offered to Mike Johnson and the office. He encouraged people to provide input as the system is built.

NOAA's Climate Program is emerging and is being managed following NOAA's themes. The Program consists of Observations and Analysis, Climate Forcing, Prediction and Projection, Climate Impacts on Ecosystems, and Regional Decision Support. A long-term strategy is needed as we try to work toward a Climate Service.

The roles and responsibilities of the Climate Program Office include planning (near and long-term), budgets, decision-making, management and feedback to the NOAA administrator and management on a quarterly basis to talk about how well we're managing the office and spending the money.

Realistic performance measures are in the works as we try to accomplish and use them to measure program progress. The FY 2004 budget is being executed, FY 2005 is being debated, and the FY 2006-2011 plans are being formulated. The Climate Office is made up of OGP and Climate Observations and Services. The Interagency Observations Working Group within the Climate Change Sciences Program coordinates issues dealing with climate observations, leverages resources, and is connected with GEO and writing a national plan for climate observations.

Key emerging themes involve GEO, the Group on Earth Observations, and how the Climate Program fits in, and ocean observations and the need for integration, to test effectiveness, and the desire to build products and services from this network.

Resources are necessary to formulate science or expert teams and to begin to evaluate data and the observing system as a whole. What should these teams look like? How can we make a connection to the operations system? What is the value added so others can get the best out of observing system?

The TAO transition is a policy decision converting the project to operations in the NWS. The TAO project is the crown jewel of NOAA climate. Comments are welcome on this topic and discussion is needed regarding the steps forward and what is meant by transparent to the user involving performance measurements.

The Climate Observation Program
Meeting Objectives, Program Planning, Budget

Mike Johnson, Director, NOAA Office of Climate Observation

Mike Johnson discussed the logistics and objectives of the Office of Climate Observation Annual System Review, provided an overview of the Climate Observation Program, and described Program planning & budget.

The overall meeting objectives include reporting program progress, soliciting user feedback and system evaluation, cultivating partnerships, engaging in strategic planning, and inviting external review of the program.

One of the primary purposes in meeting each year for the System Review is to provide a regularly scheduled forum for data users to talk to data providers. All project managers are asked to consider this feedback in preparing their annual work plans. Much of the agenda is focused on presentations from data users.

Posters and accompanying oral introductions have been incorporated into this year's meeting to serve as a mechanism to report on project progress. A 2-hour reception provides time for all to view the posters. A subset of last year's posters were distributed internationally and used to highlight system status and advancements.

There has been concern by some that the System Review meeting does not place enough emphasis on project accomplishments. Volunteer(s) were invited to organize a science/technical workshop to be held in conjunction with next year's System Review in order to place more emphasis on this aspect of the review.

Cultivating partnerships with other programs is an essential element of the global climate observing system. Several essential partner programs are on the agenda. The Climate

Observation Program made good progress during 2003 in developing interagency and internationally with ties particularly with the CCSP, OOPC, and JCOMM – these are now all advocating implementation goals and strategies similar to those of our Program Plan.

Engaging in strategic planning is essential; this year's focus is on two issues: 1) ocean analysis and expert teams; and 2) the TAO transition from PMEL to NDBC management. The agenda allows time for discussion of these and other issues that participants might wish to bring forward.

External review of the program is through the Climate Observing System Council (COSC). COSC members participate in the System Review meeting as well as hold a one day meeting immediately following, with open and executive sessions.

The GCOS 2nd Adequacy Report, the CCSP Strategic Plan, and the Ocean.US plan for Implementation of the Initial U.S. IOOS all state that the ocean networks lack global coverage. Global coverage is the fundamental requirement for the system. There are many challenges for the Climate Observation Program including reaching milestones for global deployment of each network (e.g., drifters and Argo with 1250 and 3000 deployments, respectively). The GLOSS network now has an international plan for moving the program forward. Expansions to include moored buoys in the Indian Ocean and 45 HDX and FRX lines are scheduled. The ships of opportunity are necessary for deployment of the drifting arrays so completing the HDX and FRX lines must become an immediate priority.

JCOMM has adopted a standard base map projection for display of all the networks. All project managers are encouraged to modify future presentation maps to utilize the standard projection. For performance evaluation, the standard designation is to use blue for good and progress across the rainbow to red for bad.

The $4.7 million increase to the FY 2004 budget is being applied incrementally across all networks. FY 2005 budget planning currently shows an increase of $10.7 million, which will probably result in about $8 million net to the Program, assuming Congressional appropriation of the President's budget.

Group on Earth Observations: Implications for the Climate Observation Program

Greg Withee, Assistant Administrator for Satellite and Information Services

Greg Withee's responsibilities include serving as leader of the NOAA Observing Systems Council, bringing together the line offices of climate and other goals. Discussion was held about the role of the Group on Earth Observations (GEO) as an outcome of the international Earth Observation Summit established in July 2003.

The Summit represented a high level governmental/political commitment to move toward a comprehensive, coordinated, sustained global network. A declaration was issued supporting this concept and this launched development of a 10-year implementation plan establishing GEO.

Some of the key aspects of the GEO involve addressing capacity building needs, exchanging observations in a full and open manner, and devising a 10-year implementation plan. The process ends next February in Brussels. The Implementation Plan Task Team will continue with development of the 10-year plan (15 US agencies are involved in doing this job).

The U.S. 10-year Implementation Plan focuses on:

- societal benefits:
- reduced loss of life and property from disasters
- protection and monitoring of ocean resources
- understanding climate, and assessing and mitigating climate change impacts
- supporting sustainable agriculture and combating land degradation
- understanding the effect of environmental factors on human health and promoting well being
- developing the capacity to make ecological forecasts
- protecting and monitoring water resources

Annual Report Review

Diane Stanitski, Associate Program Manager, Office of Climate Observation

Diane Stanitski provided a brief overview of the first *Annual Report on the State of the Ocean and the Ocean Observing System for Climate.* She thanked all who contributed to the report and then summarized the report format and FY 2003 findings. Key achievements in the global ocean observing system over FY 2003 were highlighted and the session was opened for questions, comments, and discussion concerning ways to improve the report before making it available on line and on CD. Suggestions were also welcomed regarding ways to improve the report for next year.

Session 2: Illustrated Posters I
Chair: Sidney Thurston

This session provided an opportunity for all PIs funded by the OCO and all other interested parties to introduce and present a poster. Participants were invited to put together an AGU/AMS style portrait-oriented poster to highlight their network/project accomplishments. Last year's posters were highlighted on the Climate Observation Program's web site and ten were inserted into an OCO brochure. The brochure received international attention in 2003 at the Earth Observation Summit and the UN Conference of the Parties. The scheduled Illustrated Poster session allowed each poster presenter two minutes and one visual (overhead transparency or PowerPoint slide) to provide a brief introduction to their poster to the workshop participants.

Thirty-nine posters were presented. Poster abstracts are available in Appendix E of this report. All posters can be found on-line at www.oco.noaa.gov. Following poster introductions, there was time to view the posters during the lunch break.

Session 3: User Evaluation and Recommendations: Operational Centers, Research Programs, Assessment
Chair: Ed Sarachik

Seasonal Forecasting Priorities for the Observing System, Part 1

David Behringer
Environmental Modeling Center, NCEP/NOAA
Yan Xue
Climate Prediction Center, NCEP/NOAA

The new Global Ocean Data Assimilation System (GODAS) at NCEP is based on a quasi-global configuration of the Modular Ocean Model (MOM) v.3 developed at GFDL and a 3D variational assimilation scheme. The GODAS has been operational at NCEP since September 2003. The primary purpose of the GODAS is to supply initial ocean conditions for the new global ocean – global atmosphere Coupled Forecast System (CFS) now under development. A long retrospective analysis (1979-2003) with the GODAS has provided the basis for an extensive sequence of hindcasts with the CFS. The results of those hindcasts indicate that the CFS has significantly improved skill in forecasting Nino 3.4 SST anomalies when compared with NCEP's current operational forecast model (CMP12). The new CFS will become operational in 2004.

The data backbone of the GODAS is the set of temperature profiles provided by XBTs, Argo floats and by the TOGA-TAO and other tropical moorings. In 2003, the average number per month of assimilated temperature profiles in each category was 2055 XBT profiles, 2378 Argo profiles and 2206 daily averaged TAO profiles. The GODAS also assimilates synthetic salinity profiles based on the temperature profiles and a local climatological TS-relationship computed from the NODC World Ocean Atlas. Although sea surface temperature (SST) is not assimilated using the variational scheme, the GODAS SST is relaxed to the weekly NCEP SST OI analysis.

In the near future, altimetric sea level data will be added to the data types assimilated into GODAS. NCEP will also begin using directly observed Argo salinity profiles rather than synthetic profiles based on Argo temperature profiles. The present use of synthetic salinity profiles in GODAS suppresses much of the near surface salinity variability and the Argo salinity data should help to correct this problem.

Seasonal Forecasting Priorities for the Observing System, Part 2

Yan Xue
Climate Prediction Center, NCEP/NOAA
David Behringer
Environmental Modeling Center, NCEP/NOAA

The NCEP's new global ocean data assimilation system (GODAS) is used to provide oceanic initial conditions for the new global ocean-atmosphere Coupled Forecast System (CFS), and to provide the best estimate of the state of the ocean in support of ENSO monitoring and prediction, climate assessment and forecast in general at the Climate Prediction Center of NCEP. Various *in situ* observations, particularly surface drifter current data, CTD and ADCP data from cruises, are used to evaluate the system. GODAS provides a better analysis of temperature, salinity and sea level height fields for the Pacific Ocean than the operational Pacific regional ODAS. However, assimilation of synthetic salinity using climatological T/S relationship seriously underestimated sea surface salinity variability, which causes large errors in surface currents. In contrast, simulation run forced with the reanalysis-2 E-P flux (without data assimilation) simulates surface currents much better than GODAS does. Surface current errors are slightly reduced when more weight is given to model salinity than to synthetic salinity in the mixed layer during data assimilation, which suggests that sea surface salinity plays an important role in controlling oceanic circulations. So direct surface and subsurface salinity observations are urgently needed for replacement of the synthetic salinity in GODAS.

Our future plan is to assimilate altimetric sea level into GODAS, which we expect to improve surface current fields. More direct current observations are preferred to verify model currents. Surface flux forcings are known to have large uncertainties, and their impacts on oceanic circulations are going to be investigated. Intraseasonal variations in low-level winds and atmospheric convection, related to phenomena such as the Madden-Julian (30-60 day) Oscillation, equatorial westerly wind bursts, mid-latitude blocking, and other persistent weather regimes, have significant impacts on oceanic conditions, such as the initiation of oceanic Kelvin waves in the tropical Pacific. Those intraseasonal variations in ocean could accelerate or delay ENSO development, particularly during transition periods. Short-term climate forecasting (climate “nowcasting”) depends crucially on our ability to obtain real-time information of those intraseasonal variations.

We are going to evaluate the intraseasonal variabilities in GODAS using both *in situ* and remote sensing observations.

Ocean Data Assimilation Activities at NOAA/GFDL

Matthew Harrison, Ants Leetmaa, Anthony Rosati, Andrew Wittenberg, Shaoqing Zhang
Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey

Matthew Harrison stated that ocean modeling requires data assimilation and that there are uncertainties related to air-sea fluxes and model physics. Ocean data assimilation (ODA) produces consistent ocean states serving as initial conditions for model forecasts. The reconstructed time series of ocean states with a 3D structure aids further understanding of the dynamical and physical mechanisms of ocean evolution. Ocean analyses are used for model simulation or hindcast verification. However, ocean data assimilation products do not all agree reflecting uncertainty in models and data assimilation methods. ODA does not necessarily lead to model improvement nor to increased understanding.

Ocean data assimilation activities include quality control, models, and assimilation algorithms. Ocean observation analysis requires a GODAE server near real-time data stream and in-house quality control of the data.

The Geophysical Fluid Dynamics Laboratory will be expanding its ocean data assimilation activities starting this year through a partnership with the ECCO group in an attempt to estimate the circulation and climate of the ocean. ENSO forecasts continuing at GFDL (a new area in data collect collection trend) are found at http://nomadsgfdl.noaa.gov LAS/DODS. 3Dvar is routinely used for SI forecast initialization. The tropical Pacific is well constrained in the upper 300 m. Mid-to-high latitudes are more problematic due to sparse data outside the trade routes. Mid to high latitudes are also more problematic due to sparse data outside of the trade routes and few salinity measurements. A better job is now being done reproducing the seasonal cycle so an improvement in the ability of the model to forecast has been seen although there are some slight density issues. The forecast skill has somewhat improved. They are currently using forecast models and seeing what withholding portions of TAO moorings result in and how close the models are to reality.

CLIVAR (The International Climate Variability and Predictability Program)

Robert Weller, Woods Hole Oceanographic Institution

An overview of CLIVAR was presented along with a discussion of how CLIVAR both depends on and supports the NOAA Climate Observation Program. U.S. CLIVAR's goals are to: 1) Identify and understand the major patterns of climate variability on seasonal, decadal, and longer time scales and evaluate their predictability; 2) Improve seasonal to interannual predictability and develop the basis for decadal and longer predictability; 3) Document past rapid climate changes and their mechanisms; evaluate the potential for future abrupt changes; 4) Evaluate and enhance models used to project climate change due to human activity; and 5) Detect and describe any global changes that occur. CLIVAR is a global program with a 15-year life. Its approach to achieving its goals is to rely on broad scale, basin-wide sampling of the oceans, intensive studies of ocean, atmosphere, and coupled processes; studies of existing data; modeling; and assimilation of the broad-scale sampling using models to produce dynamically consistent gridded data sets.

CLIVAR counts on the Climate Observation Program for the implementation and maintenance of key elements of the broad scale sampling, including ARGO, surface drifters, VOS lines, and surface reference sites. In return, the more detailed sampling done during CLIVAR process studies and CLIVAR's efforts to improve predictability and to develop applications will provide guidance for how broad scale sampling should evolve. CLIVAR's Climate Process Teams are at work to take observations, develop new parameterizations, and test those parameterizations for use in operational models. A fruitful interaction between CLIVAR and the Climate Observation Program should be developed that would foster the transition of what is learned in CLIVAR about how best to observe regions of the ocean and critical climate processes in the coupled system, would share the effort to develop data-assimilation based products based on the broad scale observations, improve the incorporation in real time of accurate in-situ data in operational models, and work toward production of climate-oriented reanalysis products. CLIVAR can also work with the Climate Observation Program to foster multi-agency observational programs, such as the joint CLIVAR and carbon repeat ocean sections and the development and use of new ocean observatories; both of these efforts bring the support of the National Science Foundation together with the NOAA support of the Climate Observation Program. For CLIVAR, it will be important that the Climate Observation Program provide coordination of the broad scale sampling with international partners and works with those partners to achieve global coverage. Finally, there is strong synergy between research on improving understanding of and predictability of global climate variability and climate observations; and a balance of research and observations will strengthen both CLIVAR and the Climate Observation Program.

On Observing Systems and Forecast Models

Eli Galanti – International Research Institute for Climate Prediction (IRI)
with Mike Tippett, Tony Barnston, and Steve Zebiak

We start by presenting the IRI operational seasonal climate forecast system. The system's forecast skill depends strongly on predicted SST seasonal anomalies. Improving our ability to forecast tropical SST (a function of both the quality of the dynamical models and of the abundance of oceanic observations) is therefore one of the most urgent needs of IRI.

We then show results from a set of experiments from the ODASI consortium, where the effect of omitting portions of the TAO array on ENSO forecast skill is examined. Both the eastern and western sections of the TAO array are important for forecast skill, with the western section contributing mostly to the skill in the central Pacific. However, due to the small number of ensembles and cases analyzed, the differences, while clearly visible, do not attain statistical significance.

Next, we use a simple ENSO model to consider the role of observing system lifetime in determining observing systems impact on forecast skill. When a new observing system is available for a short period (5-20 years), even within a simplified model framework, significant improvement in forecast skill is not guaranteed to be detectable. Furthermore, including seasonality in the analysis makes judgment of skill improvement even harder.

Finally, we discuss the current state of observations evaluation by forecasting and modeling centers. The observation community requires the expertise of the modeling and forecasting communities to evaluate the usefulness of new observational systems in forecast systems. The forecast centers and modeling community, on the other hand, while incorporating new observations in models, are constrained to focus resources on making the best possible forecasts, and often do not have the mission (or available resources) to conduct rigorous assessments of the sensitivity of forecast systems to observing systems. We therefore propose that new observing systems programs include an integrated element of collaboration with forecast/modeling centers for the purpose of evaluating new observations in the context of state estimation and climate prediction.

Session 4: Illustrated Posters II
Chair: Sidney Thurston

This session provided an opportunity for the remaining PIs funded by the OCO and all other interested parties to introduce and present their posters. Participants were invited to put together an AGU/AMS style portrait-oriented poster to highlight their network/project accomplishments. The scheduled Illustrated Poster session allowed each poster presenter two minutes and one visual (overhead transparency or PowerPoint slide) to provide a brief introduction to their poster to the workshop participants.

Thirty-nine posters were presented. Poster abstracts are available in Appendix E of this report. All posters can be found on-line at www.oco.noaa.gov. Following poster introductions, there was time to view the posters during a two-hour evening reception in the poster room.

WEDNESDAY
14 April 2004

Session 5: User Evaluation and Recommendations: Operational Centers, Research Programs, Assessment (continued)
Chair: Ed Sarachik

International Ocean Carbon Coordination Project

Maria Hood – Intergovernmental Oceanographic Commission of UNESCO

Maria Hood of the Intergovernmental Oceanographic Commission of UNESCO provided an overview of the International Ocean Carbon Coordination Project (IOCCP). The ocean is the largest mobile reservoir of carbon on decadal to millennial timescales, and will serve as the ultimate sink for ~90% of the anthropogenic CO_2 released to the atmosphere. Uncertainties of ocean carbon sink behavior lead to large discrepancies in model projections of atmospheric CO2 concentrations at the end of this century. Implementing the required global ocean carbon observing system for research will require international collaboration and coordination on an unprecedented scale. The International Ocean Carbon Coordination Project is a joint pilot project of the SCOR-IOC CO_2 Panel and the Global Carbon Project. The goal of the pilot project is to develop a central, program-independent "hub" where any ocean carbon activity can plug-in to form part of the cooperative network, following internationally-agreed strategies for observations. Since its beginning in 2003, the IOCCP has held two major workshops and sponsored an international intercomparison exercise for underway pCO_2 systems. The IOCCP has produced an on-line information base of ongoing and planned ocean carbon activities, recommended practices on data and metadata formats for underway measurements, recommended practices for data exchange and integration, and will soon publish a *Guide of Best Practices for Oceanic CO_2 Measurements and Data Reporting*. The IOCCP is working closely with the Global Climate Observing System and the Ocean Observations Panel for Climate to integrate strategies and observing system elements with the existing observing system. http://ioc.unesco.org/ioccp.

Objective Evaluation of an In Situ Observing System for Climate SST

Richard W. Reynolds, Huai-Min Zhang, and Thomas M. Smith
National Climatic Data Center/NESDIS/NOAA

A method was presented to evaluate the adequacy of the current in situ (ship and buoy) network for climate sea surface temperature (SST) analyses which use in situ and satellite observations. Because of the high spatial and temporal coverage of satellite data, in situ data are only necessary to correct any large-scale satellite biases. Simulations were used to define a potential satellite bias error as a function of in situ data density. Before the simulations, recent satellite biases were analyzed. It was shown that the magnitudes of satellite biases could exceed 2^oC. These biases have occurred due to aerosols and near the end of the lifetime of satellite instruments. Because future biases could not be predicted, the in situ network must be designed to correct for any possible biases that have occurred. Thus, the simulations were designed with satellite biases of 2^oC in maximum RMS bias over the global ocean. Buoy data were simulated at different grid resolutions to show their ability to correct the satellite biases. The goal of this study was to define the in situ network which would reduce the simulated biases below 0.5^oC.

Results of the simulations showed that a buoy density of 2 on a 10^o spatial grid was required. The present in situ SST observing system was evaluated to define an equivalent buoy density, which allows ships to contribute along with the buoys. Seasonal maps of the equivalent buoy density were computed to determine where additional buoys were needed. The results will influence future buoy deployments. In addition, average potential satellite bias errors could be computed from the equivalent buoy density. This allows the evaluation of the present in situ observing system for climate SST.

Ocean Heat Content and the Upper Ocean Observing System - A Critical Look from a User Perspective

Sydney Levitus, Director, World Data Center for Oceanography, NOAA

A grand scientific challenge involves quantifying earth's heat balance and earth's freshwater balance. Technology, including Argo floats and altimetry, exists to enable this to happen. 1.7 million temperature profiles have been added to the World Ocean Database with the release of World Ocean Database 2001. New computations based on this database confirm that the heat content of the world ocean has increased during 1955-99. A separate observing system, satellite altimetry provides an estimate of a 2.8 m/year increase in global sea level from 1993 to the present. It can be inferred that the world ocean has warmed and/or become fresher during this period. ERBE data show no change in net radiation in the 20°S-20°N latitude belt during 1985-1999.

The necessary steps to characterize the ocean component of the earth's heat balance include building the ocean profile databases necessary to compute ocean heat content by: 1) continuing to add historical ocean profile data, 2) continuing to add modern ocean profile data not sent via GTS, and 3) improving real-time ocean profile data management.

It is important to compute ocean heat content in near real-time because it is a critical metric of the state of the earth's climate system. Such computations also represent a means of monitoring the state of the ocean thermal observing system for systematic and random data errors, etc. Experience has shown that we need to use data in products to fully evaluate the quality of the data. Errors may enter databases and stay there for years or become "unfixable" if not identified close to data observation time.

XBT, XCTD, profiling float, moored buoy and drifting buoy data that are transmitted over the GTS are made available via various servers. Our source is the Global Temperature-Salinity Profile Project (GTSPP) database.
There are many quality-control problems with real-time and delayed mode data including profiles that are not properly identified, numerous "near duplicates" (e.g., same temperature profile but different years, months, or days); incorrect metadata (e.g., bad dates, locations). It is time-consuming, labor-intensive work to identify and correct problems.

There is substantial work being done by several centers, but their work needs to be expanded and improved. Many solutions to the problems exist including identifying and fixing metadata problems in near-real-time etc., and identifying data quality problems by using the data to generate scientific products.

Ocean data management is underfunded and understaffed at most centers. We need to "correct" data in near real-time to produce a higher quality database for community use, or fix it later with potential permanent loss of more data as more time goes by.

Global Sea Level Rise: The Past Decade Vs. The Past 100 Years

Laury Miller[1], Bruce C. Douglas[2], Robert Cheney[2]
[1]Laboratory for Satellite Altimetry, NOAA/NESDIS, Silver Spring, MD
[2]Florida International University, Miami, FL

Based on observations from the TOPEX/Poseidon and Jason satellite altimeter missions, it now appears that global sea level has been rising for the past eleven years at a rate of 2.5-3.0 mm/yr, nearly three times greater than the lower bound of the most recent estimate by the Intergovernmental Panel on Climate Change (IPCC). This result can be interpreted in one of two ways. Either the rate of Global Sea Level Rise (GSLR) has undergone a huge acceleration in the 1990's relative to the long-term rate, or the lower bound of the IPCC assessment represents an extreme underestimate. To help resolve this dilemma, we present an analysis of tide gauge observations combined with measurements of temperature and salinity in the Pacific and Atlantic Oceans close to the gauge sites. We find that the gauge-determined rates of sea level rise are two to three times higher than the rates due to volume change as derived from the temperature and salinity data. This analysis supports earlier studies that put the long-term (100 year) rate of GSLR close to 2 mm/yr, i.e., the upper bound of the IPCC estimates, but does not exclude the possibility that sea level as accelerated above this rate in the 1990's. To help distinguish between decadal variability and true departures from the long-term rate, it is essential that the TOPEX/Jason series of high precision altimeters be maintained for at least several decades and that in-situ observing systems, like ARGO, be fully deployed.

IPCC (2007): AR4 the Next Assessment, WG1. Relevance for Ocean Observations.

Kevin E. Trenberth, National Center for Atmospheric Research

In this presentation a summary is given of the approved timetable and outline, chapter by chapter, of the next WG1 IPCC report, due in 2007. The changes in scope from the previous report will be highlighted, and these include splitting the observations chapter into 4 parts involving 1) the surface and atmospheric climate change, 2) changes in snow, ice and frozen ground, 3) ocean climate change and sea level, and 4) paleoclimate. The talk then focuses on key issues related to ocean observations for climate. Questions include: Why does SST change the way it does? What are the ramifications for climate? Where is the heat going from the radiative imbalance? What does this mean for ice melting? What does it mean for ocean expansion? What does it mean for sea level? How stable in the Thermohaline Circulation (THC)?

The uneven changes in SST appear to be responsible for changes in the PDO, NAO, Sahel drought, the Dust Bowl in the 1930s in North America, among other things, and highlight the importance of the global oceans and not just ENSO on interannual to decadal timescales. The role of the ocean in heat storage and in meridional heat transports will be emphasized. The first example is the uptake and release of heat with the annual cycle. The second is climate change and reconciliation of estimated top-of-atmosphere radiative imbalances with changes in heat content and sea level in the oceans. A flurry of 4 new papers just out or not yet published provides different and not always consistent views on this and highlights outstanding issues. Where heat is deposited in the vertical in the ocean makes a difference for sea level owing to the change in expansion coefficient with temperature. Potential changes in the THC are suggested by models and raise questions about its stability. These questions are highlighted by new media attention to this issue through such preposterous disaster movie spectacles as "The Day After Tomorrow", due for release in late May.

Many new observations and analyses will need to be assessed for IPCC. All of the examples highlight the need to do better in the surface heat balance and change, and the need for a much better ocean observing and analysis system.

Lead authors for the IPCC Report will be announced in April 2004; a first draft is due in August 2005; and the report should be published in January 2007.

Session 6: Partnerships
Chair: Lynne Talley

Argo Program
John Gould, Director of International Argo

Argo is now approaching the point where 1200 floats (40% of the target array) are delivering data and completion of the array around 2006 seems attainable. Argo is now the main source of profile data from the global ocean - its over 4000 monthly profiles exceeds the typically 2500 XBT drops exchanged in real time. About 80% of Argo data are available to users within 24 hours via the GTS or from two Global Data Assembly Centers with gross errors corrected or flagged. The data are quasi-randomly distributed in space (target is a 3 degree x 3 degree average) and uniformly in time. Profiles are to a maximum depth of 2000 m. Choice of profiling depth is a compromise between scientific value (deeper profiles explore more of the water column and sample the more stable theta-s regime) and energy budget. In general deeper profiling is used at higher latitudes. A uniform drift depth of 1000 m is now being advised to allow the estimation of basin and global scale velocity fields. Technically, building and maintaining the array from contributions from 18 countries is demanding. In the past two years several causes of premature float failure have been identified and corrected. Since floats have a design life of 4 years, the process of assessing improvements in float performance has a comparable time scale.

The Argo data set is novel in terms of its spatial and temporal distribution and is already being used by around a dozen operational ocean and climate analysis and forecast centers. A survey of these centers revealed greater use of salinity data outside the USA. The process for delayed-mode quality control of salinity data, based on comparisons with ship-based climatologies and PI input, has been agreed and will be fully implemented later in 2004. This process imposes a delay of about 1 year in delayed mode data delivery; it also requires a sustained program of high quality shipboard CTD data collection to ensure that reference climatologies are updated. Widespread use is being made of Argo data in addressing problems as diverse in timescale as air-sea interaction beneath tropical cyclones, monsoon variability and ENSO forecasting, decadal scale change in water masses and circulation and the detection of anthropogenic change. Such examples and operational uses were given at the Argo Science Workshop (supported by NOAA and JAMSTEC) in November 2003. The challenges for Argo are completing and maintaining the global array, further improving float reliability, assessing and incorporating new technologies (two-way communication with greater bandwidth, new and improved sensors) and widening the research and operational use of Argo data and responding to the requirements of a diverse user community. The US contribution (providing 50% of the global array, 85% of floats and 100% of the present sensor suite) is central to the success of Argo and is the base on which other nations' contributions are leveraged.

Ocean Research Interactive Observatory Network: ORION

Kenneth H. Brink, ORION Project Office

The ORION project represents a science-driven capability for making time series measurements in the ocean on a more-or-less permanent basis. The system will feature real-time data access, ability to control sensors, high bandwidth communications and ready access to electrical power. These are exciting new capabilities that will call for an entirely new way to think about ocean measurements.

The ORION system will consist of three major parts. The coastal parts will include permanently located assets, as well as moorings that can be relocated on a 3-7 year basis depending on science priorities. The regional cabled part of the observatory network will involve thousands of kilometers of fiber optic cable that will cover key points on the Juan de Fuca plate, offshore of Oregon-Vancouver Island. Finally, the global part of ORION will involve highly capable moorings located around the world's oceans and that allow data to be collected from below the seafloor to above the ocean surface.

Detailed planning for ORION is now going into high gear, with the expectation that implementation can start in Fall 2005. This process needs to include coordination with other programs, and so alliances with NOAA activities are highly desirable.

U.S. Global Climate Observing System (GCOS) Program Overview
The Atmospheric Domain

Howard Diamond, U.S. GCOS Program Manager, NOAA/NCDC

This was the first opportunity for the atmospheric aspects of the U.S. GCOS Program to be briefed to the OAR Climate Observing System Council as well as the OCO Annual Review. In his role as the U.S. GCOS Program Manager, Howard Diamond from the National Climatic Data Center provided a background of the U.S. GCOS Program, a review of the various GCOS Atmospheric Networks (e.g., GCOS Surface Network, GCOS Upper Air Network, Global Atmosphere Watch, Atmospheric Brown Cloud, and the Baseline Surface Radiation Network including the U.S. SURFRAD Network). He also covered the support that U.S. GCOS is providing in support of international GCOS support and regional and bi-lateral activity support. As such he went over the funding and budget planning for GCOS that included a review of FY03 accomplishments, plans for FY04 activities, and planning associated with FY05 and beyond. Finally, he detailed some specific regional support in the Pacific Islands region related to regional GCOS activities, as well as with a new NOAA initiative in the Pacific Region known as PRIDE (Pacific Region Integrated Data Center for Environmental Ocean, Climate, and Ecosystem Information and Services). PRIDE will leverage a number of existing NOAA activities based in Hawaii, and in particular he noted that as the NOAA lead for the International Pacific Research Center (IPRC) and subsidiary Asia Pacific Data Research Center (ADPRC) that NOAA was working with the IPRC management to expand into data management on the atmospheric side of climate and the Atmospheric Brown Cloud (ABC) would be a great regional application for this. Links to the IPRC and APDRC can be found respectively at http://iprc.soest.hawaii.edu and http://adprc.soest.hawaii.edu.

Some key bi-lateral climate agreements that the U.S. has with countries such as New Zealand, Australia, South Africa, and China were mentioned. In particular two new bi-lateral activities being supported as part of the U.S./New Zealand Climate Change Partnership were described that includes some exciting new trace gas measurements on a new ship route between New Zealand and Japan that crosses the South Pacific and Inter Tropical Convergence Zones was described, as well as the establishment of a new stratospheric water vapor measurement site in Lauder, New Zealand, to complement the current one global site in Boulder, CO was detailed. Howard is basing the priorities of the $4.0M annual GCOS program on priorities from the GCOS Atmospheric Observations Panel for Climate (AOPC), NOAA Climate Monitoring Working Group, the GCOS Secretariat, as well as from regional workshops and inputs from bi-lateral climate partners.

As an advertisement, Howard detailed a joint session on Global Environmental Observing Systems at the 85th annual AMS meeting scheduled for January 9-13, 2005, in San Diego, CA. In conjunction with the 21st Interactive Information Processing Systems (IIPS) and the 9th Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface (IOAS-AOLS) Conferences this session is related to global environmental observing systems including, but not limited to, the Global Climate Observing System (GCOS), Global Ocean Observing System (GOOS), and Global Terrestrial Observing System (GTOS). This joint session is directly related to the overall theme of the 85th AMS Meeting of "Building the Earth Information System" It is timely, given the recent work related to the Earth Observation Summit, and related Group on Earth Observations (GEO). Abstracts for this session may be submitted either to the IIPS or to the IOAS-AOLS conference. Howard encouraged persons to view the AMS web site for more details at http://www.ametsoc.org/ and consider submitting an abstract related to this joint session.

Observations and Research on Arctic Components of the Global Climate System

John Calder and Kathleen Crane, NOAA Arctic Research Office

The goals of the Arctic Research Office (ARO) are to 1) Achieve an effective climate observing system focused on the U.S. region of the Arctic to allow for regional-scale climate change detection and modeling with useable level of uncertainty; 2) Facilitate the international cooperation in the installation of climate observing systems in the circum-Arctic region 3) Create and analyze Arctic physical and biological data sets designed to detect climate change, validate satellite observations, improve and initialize models, support decision-making; and 4) Through partnerships, develop Arctic-wide observing and modeling capability to detect and assess Arctic-wide change and impact, and determine how Arctic processes affect North American and global climate systems. There is clear scientific evidence that a complex suite of seemingly interrelated atmospheric, oceanic and terrestrial changes has occurred in the Arctic in recent decades. The most well known of these are general warming, loss of sea ice and glacier mass, thawing of permafrost and other temperature-related phenomena. Changes in precipitation and storminess are suspected but not well documented. Less well known are changes in biological activity (spruce bark beetle outbreak, changing whale migration, northward movement of marine and terrestrial species, marine regime shifts) and in the social fabric of Native communities. These changes affect every part of the Arctic environment and have significant impacts on society. Because of relationships between Arctic environmental processes and those of mid-latitude areas, environmental change in the Arctic influences environmental conditions in more heavily populated regions as well, making the ARP relevant not just for Arctic residents, but for most of North America, northern Europe and northern Asia including China.

The ARO is coordinated with other U.S. government agencies through the Study of Environmental Arctic Change (SEARCH) program. The specific role of the ARP is long-term climate observations and analysis of Arctic climate data. For FY2004, the ARO will carry out a joint U.S. and Russian Federation expedition to the Russian Chukchi Sea to gather critical baseline information necessary to provide data about the ecosystem indicators of climate change in this very sensitive region. In FY2006, the ARO will continue to focus on four key aspects of the Arctic climate system whose results will improve forecasts of temperature, precipitation and storminess across Alaska and the mainland U.S., and support improvements in forecasting and planning for energy needs, growth seasons, hazardous storm seasons and water resources, as well as provide for better management of Alaskan and Arctic resources.

a. The first is a project to improve detection of change at the Arctic air/ice/ocean interface that provides data on ice thickness and motion, surface and under-ice water temperatures, and incoming and outgoing radiation. These data will improve estimates of the Earth's radiative balance and Arctic feedbacks on global climate processes through changes in albedo and changes in ice volume and movement. These data will also be useful for monitoring the seasonal availability of new and existing northern shipping routes.

b. The second is a project to improve detection of change in the lower and upper atmosphere, by providing data to determine the drivers, intensity and impacts of the Arctic and North Atlantic Oscillations - atmospheric modes that are important in improving climate and weather forecasts. A circum-Arctic network of atmospheric observatories is planned, with the NOAA Barrow Observatory as the prototype.
c. The third activity involves the aggregation, quality control, and analysis of Arctic environmental data to provide high quality Arctic data sets that include satellite, surface, and radiosonde observations, along with model results, all optimized for the Arctic, to support climate change scenarios, long-term environmental management, energy planning, and possible mitigation of anthropogenic impacts.
d. The fourth activity recognizes the importance to the U.S. of understanding the relationships between climate change and marine ecosystem change. The Bering Sea and Chukchi Sea lie in areas predicted to undergo rapid and large climate change. This area will serve as a test bed for relating changes in the physical environment to the biological resources in the region, and results here should provide guidance for similar studies in other marine areas.

Session 7: Issues
Chair: Greg Mandt

Ocean Analysis and Expert Teams

Mike Johnson, Director, NOAA Office of Climate Observation

One outcome of last year's annual workshop was identification of the issue that a program of ocean analysis is lacking within NOAA. A major question before the Program is whether the Climate Observation Program should fund ocean analysis as a primary activity. If not, who should fund analysis? If so, what percent of the budget would be reasonable? It is still apparent that expert teams need to play a role in product and system evaluation. Expert teams are also needed to help with the Annual Report. The problem, identified last year, is that there are few ocean products to evaluate at this time. Do we need teams to develop products before we establish teams to evaluate products?

A draft framework for expert teams (the ocean component) was presented including four goal teams focused on the state variables and three mission teams focused on NOAA's mission. Another approach might be to establish just one overarching team with seven areas of responsibility.

Possible alternative team-forming approaches were presented for discussion:

1. Soliciting proposals for seven Expert Teams to self-organize,

2. Soliciting proposals for a Science Team to cover all seven goals and missions,
3. A phased approach to select a priority goal and conduct a community-wide workshop to determine what products are operational, what products are needed, and then to solicit proposals or select institutions to deliver needed products operationally.

TRITON Array Operations

Toru Nakamura
Washington D.C. Office, Japan Agency for Marine-Earth Science and Technology

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called "warm pool" affects the global atmosphere and causes El Nino phenomena. In order to understand occurrence mechanism of El Nino phenomena, JAMSTEC has been actively engaged in long-term oceanographic and meteorological observation with a moored surface-buoy array in the equatorial region since 1998. The array is named the TRITON and the buoys have been deployed in the western equatorial Pacific and in the eastern Indian Ocean. This buoy array project is the joint project with NOAA/PMEL.

The TRITON buoy is equipped with meteorological and oceanographic sensors. The sensors measure every 10 minutes. Those data are averaged for 1 hour and transmitted via the ARGOS system. When the data come into the Mutsu Institute of JAMSTEC, the quality is checked and the validated data are sent to PMEL. After receiving the TRITON data, PMEL integrates them with TAO data, and creates common format gridded data. Finally, JAMSTEC and PMEL distribute the data from their web sites. However, the TRITON buoys have encountered major problems where meteorological sensors or tower was broken or stolen. JAMSTEC works on overcoming this problem.

TAO Transition

Paul Moersdorf, National Data Buoy Center (NDBC)

The revised Transition Plan for the operation and maintenance for the Tropical Atmosphere Ocean (TAO) buoy array was presented. The transfer from the Pacific Marine Environmental Laboratory (PMEL) to the National Data Buoy Center (NDBC) also includes the Pilot Research Array in the Tropical Atlantic (PIRATA). The TAO Transition is being conducted in accordance with the high level guidance provided in the NOAA Executive Council (NEC) approved plan. The revised plan, the result of tasking received in November 2003 from the Climate Program Manager, details the management of the tasks, cost, and schedule for the TAO/PIRATA transition, establishes the foundation for sustained operation and technology refreshment after transition and describes further cooperation between PMEL and NDBC. The briefing addressed the highlights of the transition. Those are:

- During FY2004 NDBC will submit the FY2005 TAO proposal to the Office of Oceanic and Atmospheric Research's Office of Global Programs for funding;
- NDBC will assume management authority and operational responsibility on October 1, 2004. The TAO Chief Scientist, supplied by PMEL, will continue to provide scientific expertise and oversight as well as international liaison;
- All transition planning will occur in FY2004 and transition activities completed in FY2005;
- Initially NDBC will maintain a base of operations in Seattle and maximize proven capabilities of PMEL. A small core group of NDBC employees, made up from OAR civilians and NOAA Corps Officer, will oversee execution of the project;
- To maintain the quality and integrity of the data attention will be focused on technology refreshment for unavailable or obsolete sensors and parts;
- NDBC and PMEL will jointly develop new technologies for infusion into the operational system, including flux sites, salinity sensors and new buoy technologies;
- NOAA's external Climate Observing System Council will continue to advise and guide TAO activities; and
- The actions of the NEC approved plan will be carried out in parallel with the actual transition of operational responsibility.

Questions and discussion followed Paul Moersdorf's formal presentation regarding the TAO Transition.

THURSDAY
15 April 2004

Climate Observing System Council (COSC) Open Session

An Open Session of the Climate Observing System Council was convened to discuss the annual report, annual meeting, ocean analysis and expert team(s), tropical mooring transition plan, and role of the COSC.

Annual Report
It was determined that a concise 4-5 page Executive Summary is needed to attach to the more extensive Annual Report. This should include an overview of the state of the ocean

for policy makers and the general public. It could also serve as a contribution to the Annual State of the Climate report in the future.

Annual Meeting

Requests were made to incorporate more science in future annual meetings of the Climate Observation Program. Suggestions included holding a one-day science workshop with poster sessions focused on the science topics being discussed. Also, expansion to the international community was suggested for the future. Integration of the science is necessary, possibly with the addition of working groups or round table discussion between project PIs.

Expert Team(s)

Discussion focused on the number of expert teams that should be organized and the amount of money appropriate to fund such teams. An expert team(s) is needed to show how the system of systems is progressing and how all the systems work together. This team(s) will help manage the system and inform others about needs for the observing network. Interface teams would go between the observing system and the customers to ensure that the needs are being met.

COSC

The COSC is a discussion forum to determine the role of research and operations in the bigger scheme for each funded ocean project. The group also provides advice on what programmatic decisions need to be made.

TAO Transition

Questions were presented regarding the TAO transition and the need to move the sustained TAO array from PMEL to an operational agency, NDBC, under the NWS. In an operational system, the key is that there's an institutional commitment to make sure the program continues regardless of who is involved. The issue is that a climate observation system is being moved into a weather service. Discussion involved whether NDBC has the same commitment to the TAO array as does PMEL. Concern arose over the transition and the MOU with Japan regarding the TAO/TRITON array and data sharing and transparency. It was stated that NDBC would continue to manage the TAO Array as has been done in the past. There should be little apparent change.

Climate Observing System Council (COSC) Executive Session

The COSC Open Session was followed by a COSC Executive Session. COSC members reviewed agenda items discussed during the earlier open session, including extensive discussion of the TAO Transition and Expert Teams.

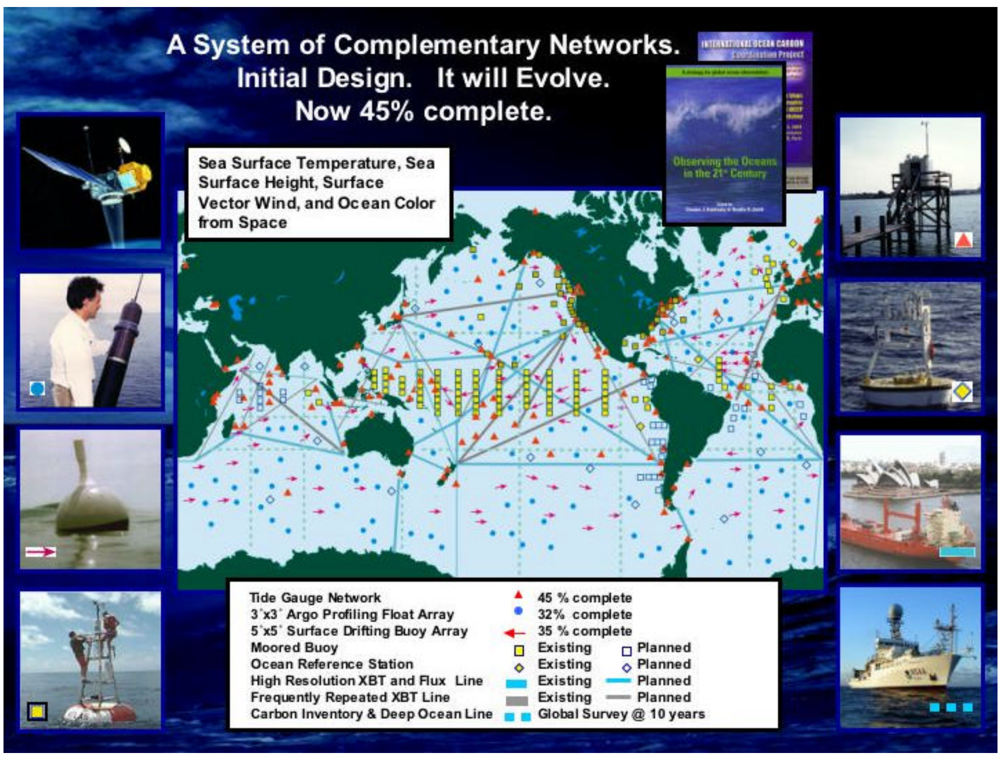
The joint 2nd High-Resolution Marine Meteorology workshop was held concurrently with the COSC Executive Session and continued through Friday, 16 April. The Executive Summary for the joint Marine Meteorology workshop can be found on this CD under HRMM2esum_final.pdf.

Appendix A: Agenda and Letter of Invitation (to view PowerPoint presentations, click on <u>OCOpresentations.doc</u> on CD)

AGENDA

Office of Climate Observation Annual System Review
13-14 April 2004

Climate Observing System Council Annual Meeting
15 April 2004



and the

Second High-Resolution Marine Meteorology Workshop
15-16 April 2004

Holiday Inn
Silver Spring, MD

AGENDA

Office of Climate Observation Annual System Review
13-15 April 2004

TUESDAY, 13 APRIL 2004

All activities will take place on the 4th floor of the Holiday Inn in the Kennedy Ballroom unless otherwise noted.

0800	Coffee, Continental Breakfast	4th Floor Adams Room
	COSC executive session	4th Floor Kennedy Ballroom
	Poster set-up	Lincoln Ballroom

0830 Session 1 – Program Overview **Chair: M. Johnson**

0830	Welcome (10 min)	K. Mooney
0840	The NOAA Climate Program – Implications for Observing Systems (30 min)	C. Koblinsky
0910	Group on Earth Observations (GEO) (30 min) Implications for the Climate Observation Program	G. Withee
0940	The Climate Observation Program (60 min) Meeting Objectives, Program Planning, Budget	M. Johnson
1040	*Break (20 min)*	
1100	Annual Report Review (45 min)	D. Stanitski

1145 Session 2 – Illustrated Posters I (2 min overview with one visual per poster; schedule follows poster abstract listing) (30 min) **Chair: S. Thurston**

Following poster introductions, there will be time to view the posters in the Lincoln Ballroom during the lunch break.

1215 LUNCH on own (1 hr, 15 min)

1330 Session 3 – User Evaluation and Recommendations: Operational Centers, Research Programs, Assessments **Chair: E. Sarachik**

1330	National Centers for Environmental Prediction (NCEP) (40 min)	D. Behringer / Y. Xue
1410	Geophysical Fluid Dynamics Laboratory (GFDL) (40 min)	M. Harrison
1450	Climate Variability and Predictability Program (CLIVAR) (40 min)	B. Weller
1530	*Break (20 min)*	
1550	International Research Institute for Climate Prediction (IRI) (40 min)	E. Galanti

1630 Session 4 – Illustrated Posters II (2 min overview with one visual per poster; schedule follows poster abstract listing) Chair: S. Thurston

Following poster introductions, there will be time to view the posters and ask questions of the authors in the Lincoln Ballroom.

1730 - 1930 Poster Session (2 hrs); Reception in the Lincoln Ballroom

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WEDNESDAY, 14 APRIL 2004

0800 Coffee, Continental Breakfast — 4th floor Adams Room
Poster Session Continued — Lincoln Ballroom

0830 Session 5 – User Evaluation and Recommendations (cont'd) Chair: E. Sarachik

0830 International Ocean Carbon Coordination Project (40 min) — M. Hood

0910 Observing System, Climate Change (40 min)

- Sea Surface Temperature — R. Reynolds
- Ocean Heat Content and the Upper Ocean Observing System – A Critical Look from a User Perspective — S. Levitus
- Sea Level Observing System Issues — L. Miller

0950 Intergovernmental Panel on Climate Change (IPCC) panel (40 min) — K. Trenberth

1030 Break (20 min)

1050 Session 6 – Partnerships Chair: L. Talley

1050 Argo Program (30 min) — S. Piotrowicz / J. Gould

1120 Ocean Research Interactive Observatory Networks (ORION) (30 min) — K. Brink

1150 Lunch on own (1 hr, 10 min)

1300 GCOS Program (30 min) — H. Diamond

1330 Arctic Program (30 min) — K. Crane

1400 Session 7: Issues Chair: G. Mandt

1400 Ocean Analysis and Expert Teams (30 min) — M. Johnson

1430 Break (30 min)

1500 TRITON Array Operations (30 min) — T. Nakamura

1530 TAO Transition (60 min) — P. Moersdorf

1630 Discussion (40 min)

1800 - 1930 **Reception and Open House** will take place at the Office of Climate Observation's new Observing System Monitoring Center, 1100 Wayne Avenue, Suite 1202

Climate Observing System Council (COSC) Executive Session
THURSDAY, 15 April 2004

0800 Coffee, Continental Breakfast — 4th floor Adams Room

0830 COSC Open Session – discussion — 4th floor Kennedy Ballroom

- Ocean Analysis and Expert Teams
- TAO Transition
- Other Programmatic Issues

1000 Break (30 min)

1030 COSC Executive Session — Chesapeake Room

1130 Lunch (1 hr) — 4th floor Adams Room

1500 COSC Adjourn

The Second High-Resolution Marine Meteorology Workshop will be held from 1030 on April 15 to 1700 on April 16, 4th floor, Kennedy Ballroom.

4 February 2004

Dear Climate Colleagues:

You are invited to participate in NOAA's Office of Climate Observation (OCO) Annual System Review workshop, scheduled from 13-15 April 2004. This workshop is the second in a series of anticipated Annual Reviews to support and provide program direction and critical review of the OCO program activities and to help continue charting the future of NOAA's contributions to the global ocean observing system. Your expertise and counsel are vitally important to the implementation and success of the OCO program.

The OCO Annual System Review workshop will be held in conjunction with the NOAA Climate Observing System Council (COSC) meeting; COSC members will be asked to use this Workshop to review the Program's progress over the past year. In addition, the 2nd High-Resolution Marine Meteorology Workshop will be held from Thursday afternoon, 15 April, through Friday, 16 April. An agenda for this workshop will be forthcoming. The location for all events is the Holiday Inn in Silver Spring, Maryland (hotel and travel details follow).

OCO Program Background

In May 2003 the NOAA Climate Observation Program agreed on the need to conduct an annual observing system review. The objective of the annual system review is to provide a regularly scheduled forum to:

1) solicit user feedback and system evaluation;
2) document and report project accomplishments;
3) cultivate and solidify partnerships (domestic and international);
4) engage in strategic planning to support NOAA's ocean program goals; and
5) invite and encourage external review of the OCO program.

To meet these objectives and bring together NOAA's global observation activities (operations and research), the Office of Climate Observation (OCO) was established within NOAA. The key objective of the OCO is to develop a programmatic direction or "Management Plan" that focuses on the *in situ* ocean networks and provides an observing structure that supports NOAA's climate goals and priorities.

The OCO Mission Statement

"Build and sustain a global climate observing system that will respond to the long-term observational requirements of the operational forecast centers, international research programs, and major scientific assessments."

OCO Program Goals

- Document and report long-term trends in sea level change
- Document and report ocean carbon sources and sinks

- Document and report the <u>ocean's storage and global transport of heat and fresh water</u>
- Document and report the <u>ocean-atmosphere exchange of heat and fresh water</u>

<u>OCO Structure</u>

- Dual reporting to the NOAA Climate Program Office (i.e., operations) and the Office of Global Programs (i.e., research)
- Focus on the *in situ* ocean networks

<u>OCO Management Plan</u>

- Subtask 1 -- Monitor the status of the globally distributed networks; report system statistics and metrics routinely and on demand
- Subtask 2 -- Evaluate the effectiveness of the system; recommend improvements (i.e., Expert Teams)
- Subtask 3 -- Advance the multi-year Program Plan; evolve the *in situ* networks
- Subtask 4 -- Focus intra-agency, interagency, and international coordination
- Subtask 5 -- Organize external review and user feedback
- Subtask 6 -- Produce Annual Reports on the state of the ocean and the adequacy of the observing system for climate

We will also celebrate the opening of the new OCO Observing System Monitoring Center with an Open House scheduled for Wednesday evening. The OCO office is located within the Office of Global Programs at 1100 Wayne Avenue, Suite 1200 (directions will be provided at the workshop).

<u>Workshop Objectives and Participant Contributions</u>

We look forward to your participation at this workshop. We can all benefit from hearing about the needs for the observing system and the means by which we can reach global coverage. This workshop is an opportunity to exchange ideas and discuss both your needs and ours. Together, we can work to enhance the observing system and quality of data available to our user groups to satisfy the needs of the greater climate community.

In addition to the overarching objectives stated above, the 2004 Annual System Review will deal with two specific issues:

1. Review of the planning for transition of TAO/PIRATA operations from PMEL to NDBC.
2. Implementation of ocean analysis and expert teams.

<u>Posters – presented by PIs funded by the OCO and all other interested parties</u>

Last year's workshop was successful due to your oral presentations and poster contributions. We are planning to have a slightly revised format this year. You are invited to put together an AGU/AMS style portrait-oriented poster to highlight your network/project accomplishments. We greatly benefited from your posters last year; all were highlighted on our web site and ten were inserted into our OCO brochure. The brochure received international attention in 2003 at the Earth Observation Summit and the UN Conference of the Parties. We have scheduled an Illustrated Poster session to allow each poster presenter two minutes and one visual (overhead transparency or PowerPoint slide) to provide a brief introduction to your poster to the workshop participants. We will have both an overhead and computer projector available for your use.

Please provide the following materials. **You can send all email contributions to diane.stanitski@noaa.gov.**

- Email a brief poster abstract (no more than 200 words) by 29 March to be included as an addendum to the meeting agenda.
- If you plan to show a PowerPoint slide as your visual during your 2-minute overview, please email the slide by 9 April so that it can be saved and placed in order on the workshop computer.
- Please make 40 (8-1/2" x 11") color copies of your poster to distribute to workshop participants during the poster session.
- Email your poster as a PowerPoint slide by 23 April to be included on our OCO web site.

All posters and abstracts will be placed on the Office of Climate Observation website. There will be time for all to view posters during an extended poster session on Tuesday evening. In case you cannot make the trip to Silver Spring we would still like to distribute handouts of your poster.

Oral Presentations – presented by User Groups and Partners

Due to time constraints, we are only able to schedule a limited number of oral presentations during the workshop highlighting our user groups and partners.

If you have been invited to give an oral presentation and are planning to use PowerPoint, please provide the following materials. **You can send all email contributions to diane.stanitski@noaa.gov.**

- Email your presentation no later than 9 April (close of business), so that it can be saved and placed in order on the workshop computer.
- Email a brief overview (1-2 paragraphs) of your presentation by 23 April. This will be included in the final workshop report.

Oral presentations are scheduled in 30, 40, or 60-minute slots, including time for questions. The preliminary agenda showing your scheduled time is included here and a final agenda will be available the morning of the workshop.

Thank you for agreeing to contribute to this workshop. We appreciate your time and will all greatly benefit from your posters and oral presentations.

Workshop Logistics

Here is the workshop hotel information.

Holiday Inn
8777 Georgia Avenue
Silver Spring, MD 20910
Tel: +1 301 589 0800, Fax: +1 301 587 4791

- Rooms are reserved for our group at a cost of $130/night including a buffet breakfast.
- A hotel parking garage is available. The rate for overnight guests is $10.00 per day for valet, $8.00 per day to self-park. Parking for non-guests is $2.00 per hour, with a maximum daily charge of $10.00 per day, or $10.00 for valet parking.
- Public transportation (metro and bus) is within walking distance.

A continental breakfast and coffee/tea will be available each morning starting at 0800 just adjacent to the meeting room. Lunch will be on your own; a local restaurant guide will be provided at the workshop. A poster reception is scheduled for Tuesday evening and a reception and open house for Wednesday night.

When you call the Holiday Inn to make reservations, state that you are with the Climate Observation group to receive the discounted rate. The closest airports are Ronald Reagan (National) and Dulles. If you fly into National you can take the metro to Silver Spring. If you need directions regarding how to most easily travel to/from an airport, please email and we will be happy to send you details.

Summary

Please share any ideas or comments that you have regarding the plan for the workshop. We will be developing the final workshop agenda over the next two months. If you believe that an important participant has been missed on the invitation list, please forward this letter to him/her and let us know so we can add to the mailing list. Thanks. We look forward to your participation in this workshop.

Kind regards,

Diane Stanitski

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Appendix B: Poster Abstracts (to view posters click on OCOposters.doc on CD)

Poster Abstracts

Climate Observation Program Annual System Review
April 13-15, 2004
Silver Spring, Maryland

Advances in the Global Ocean Observing System

Diane Stanitski, Michael Johnson, Sidney Thurston, Masahiko Kamei
NOAA/OGP, Silver Spring, MD

The NOAA Climate Observation Program supports oceanic and marine meteorology projects designed to contribute to the implementation of a global climate observing system needed to satisfy the requirements of operational forecast centers, international research programs, and major scientific assessments. NOAA has worked with national and international partners to begin building a sustained global ocean system for climate. The Office of Climate Observation (OCO) promotes the utilization of platform and data infrastructure for several objectives, including understanding the Earth's climate system, and the global carbon and water cycles. Although the focus of the OCO is to support projects that deploy autonomous *in situ* platforms, the underlying objective is to foster a "system" approach to effective international organization of complementary *in situ*, satellite, data, and modeling components of climate observation. This poster shows advances made in the global ocean observing system and the predicted evolution of the system in the near future to develop a greater understanding of sea level, carbon, heat, salinity, and air-sea exchange parameters. With the initial system design 45% complete, the OCO's goal includes enhancing each of the complementary *in situ* subsystems including addition of new tide gauges, Argo profilers, drifting buoys, moored buoys, expendable bathythermographs, ocean reference stations, and ocean carbon measurements.

University of Hawaii Sea Level Center

Mark Merrifield, University of Hawaii

The University of Hawaii Sea Level Center (UHSLC) collects, processes, and distributes tide gauge data from around the world in support of CLIVAR, GLOSS, GCOS, GODAE and other climate research activities. The measurements are used for the evaluation of numerical models, joint analyses with satellite altimeter datasets, the calibration of altimeter data, the production of oceanographic products, and research on interannual to decadal climate fluctuations. Also, in support of satellite altimeter calibration and validation and for absolute sea level rise monitoring, the UHSLC and the Pacific GPS Facility maintain continuous GPS systems at 7 tide gauge stations. The UHSLC priority for FY2005 is to bring to operational status the tide gauge stations identified as GCOS sites.

Sea Levels OnLine: A NOAA Website for Sea Level Trends and Variability

Chris E. Zervas, NOAA, National Ocean Service, Silver Spring. MD

The information in a recently published NOAA Technical Report (NOS CO-OPS 36), entitled Sea Level Variations of the United States 1854-1999, is available on the CO-OPS website (http://tidesandcurrents.noaa.gov) in an easily accessible format. Linear sea level trends were determined for 117 water level stations of the National Water Level Observation Network, which had monthly mean sea level data spanning a period of at least 25 years. The average seasonal cycle and an autoregressive coefficient of order one were also determined simultaneously. A more accurate estimate of the confidence interval is obtained by taking into account the autocorrelation of the residual time series, since a simple linear regression underestimates the confidence interval of the trend. From the main page, the user can navigate first to the state and then to the water level station of interest. For the station chosen, the sea level trend, its standard error, and the length of the data record are provided, along with a plot of the monthly time series with the average seasonal cycle removed, a 5-month moving average, the linear trend, and two lines representing the 95% confidence interval of the trend. The longest time series have the narrowest confidence intervals. Future work includes extending these analyses to other global sea level stations outside of the U.S.

"Global Drifter Program"

Peter Niiler, Scripps Oceanographic Institution, CA

The "Global Drifter Program" objectives are to: 1) Provide an 'operational' data stream of SST, sea level pressure and surface velocity, 2) Enhance research programs on ocean processes and modeling and 3) Support international ocean science programs. New technology of a Mini-SVP drifter was introduced in 2003 that will result in 2004 in an increase of 21% more drifters for the same funding. The implementation in 2003 increased the global array of from 650 to 950 drifters. Deployment methodology of Minimet wind drifters from Air Force 53rd 'Hurricane Hunter' aircraft was developed and implemented in September 2003. Published scientific research results are highlighted, including derivation of the absolute global sea level from drifter data, tracing of the shallow overturning cell in the tropical Atlantic and the computation of the single particle diffusivity in the North Pacific.

A Summary of GOOS Activities at AOML/PhOD

Steven Cook and Bob Molinari
NOAA/AOML, Miami, FL

The mission of the GOOS Center at AOML/PhOD is to provide high quality ocean data products in a timely and cost-effective manner to satisfy NOAAA nowcast, forecast, detection, attribution and research mission requirements. Specifically, the Center manages and operates NOAA's Global Drifter, Expendable Bathythermograph and SEAS Meteorological Programs. In addition to deploying instruments, the Center performs data management on the resulting information. Data tracking is performed to ensure that data pathways are continuous from sensor to user, real-time quality control is performed to identify and remedy quickly any problems with the instrumentation, delayed quality control is performed to develop climate quality data-sets, data products are generated and made available on the AOML website to provide characterizations of the present state of the upper ocean, and data are made accessible on the AOML website for users without access to global data systems. In addition, the Center develops new instrumentation when required.

Global Drifter Center (GDC) and Drifter Data Assembly Center
Mayra Pazos, Craig Engler and Jessica Redman
NOAA/AOML, Miami, FL

Satellite tracked surface drifting buoys (drifters) have been deployed by the international oceanographic community since the late 1970's for both research and operational purposes. The resulting data have provided important information on the surface currents of the global ocean as well as providing critical sea surface temperature (SST) data for the calibration/validation of satellite SST observations. The drifter project is a collaborative effort between AOML and the Scripps Institution of Oceanography and coordinated internationally with the Drifting Buoy Cooperation Panel. During the past year, 568 drifters were deployed by the GDC (430 with SST sensors and 31 with wind and barometer sensors). A redesign of the SVP by Scripps has resulted in a smaller hull and drogue (while maintaining the drogue to hull ratio) and thus less expensive drifters. In 2003, an international consortium contributed to the upgrading of 111 SVP drifters with barometers. The DAC assembled and quality controlled data from approximately 850 buoys per month during the past year.

Data Assembly Center: Data Access and Products
Mayra Pazos and Jessica Redmond, NOAA/AOML, Miami, FL

The Drifter DAC maintains quality controlled drifter data and products on the AOML web site. The data are updated every two months and the products are updated on a variable schedule. During 2003, new products were developed including: monthly drifter SST and current anomaly maps for the Atlantic Ocean, available from January, 2000; a climatology of the tropical Atlantic at one degree resolution; and drifter animations of currents and SST. In addition, the Equatorial Pacific monthly maps generated for the Climate Diagnostic Bulletin were enhanced to include 3 panels: movements of drifters during the month; monthly mean currents calculated from all buoys deployed between 1993 and 20002 and currents observed during the month, smoothed by an optimal filter; and anomalies from the climatological monthly mean.
The web address is: www.aoml.noaa.gov/phod/dac/dacdata.html

XBT Operations
Anne-Marie Wilburn, NOAA/AOML, Miami, FL

XBT operations include recruiting Voluntary Observing Ships and training ship's crew to collect the data, receiving the data at AOML via INMARSAT, performing an automatic quality control and inserting the data on the GTS within 24 hours, and collecting and forwarding to AOML complete data disks at the end of a section. AOML is responsible for maintaining low-density coverage along several transects in the Atlantic and Pacific Oceans. Because of large turnover of VOS on these lines considerable effort is directed at recruiting appropriate vessels. During 2000, over 11500 probes were deployed; 2001, 10000; and 2002 and 2003, 11000. The VOS also collect surface meteorological observations for use in marine weather forecasts and deploy satellite tracked surface drifters and profiling floats.

Upper Ocean Thermal Structure from High Density XBT Lines in the Atlantic Ocean

Molly O. Baringer, Gustavo J. Goni, Silvia L. Garzoli and Qi Yao
NOAA/AOML, Miami, FL

NOAA/OGP funds five high-density XBT lines maintained by NOAA/AOML: 1) **AX07**, located along 30°N extending from the Straits of Gibraltar to Miami, 2) **AX10**, running between New York and Puerto Rico, 3) **AX08**, sampling across the Tropical Atlantic with emphasis between 30°N and 30°S, 4) **AX18**, running between South Africa and Argentina along 35°S, and 5) **AX25**, sampling between South Africa and Antarctica. These five XBT lines have been chosen to capture and monitor thermal properties within the Atlantic. The **AX07** and **AX18** lines have been selected to monitor the net meridional flow in the upper ocean. **AX10**, **AX08** and **AX25** are meridional lines that were selected because they cross important highly variable ocean currents, namely the Gulf Stream, the numerous Equatorial Atlantic Currents and the Agulhas and Antarctic Circumpolar Currents respectively. All XBT lines are valuable in providing estimates of the mean and time dependent temperature fields with sufficiently close spacing to sample the mesoscale field (XBTs spaced between 30-50km). They all sample various aspects of the overturning circulation and hence provide useful data on heat transport and interbasin/cross equatorial exchanges. To date, more than 13,000 XBTs have been deployed in its high density mode in the Atlantic Ocean.

Upper Ocean Transports in the Atlantic Ocean

Gustavo. J. Goni and Molly O. Baringer
NOAA/AOML, Miami, FL

The high density XBT lines provide real time high resolution temperature profiles spaced 30-50 km apart along five important lines in the Atlantic Ocean. Data obtained from these lines (AX25, AX18, AX08, AX10 and AX07) are being used to investigate the interbasin mass exchange between the Indian and Atlantic Ocean, the meridional heat transport at 30S and 30N,and the zonal current system in the tropical Atlantic. These are all important components of the Meridional Overturning Circulation in the Atlantic Ocean, which is driven by temperature, salinity and wind variations. These XBT sections are critical to investigate the upper ocean circulation since they offer the only means to measure subsurface temperature fields in spatial and temporal scales to map the mean and fluctuating components of the ocean thermal structure. In the South Atlantic, AX18 also provides information on major boundary currents and their associated rings, such as the Brazil, Agulhas and Benguela currents. These lines also provide data to the community for analysis of the thermal structure of the subtropical gyre to investigate the seasonal to interannual variability in upper ocean thermal energy to monitor and understand the role that the ocean plays in climate fluctuations, and to improve the ability to predict important climatic signals such as the North Atlantic Oscillation.

Real Time XBT Quality Control and Data Tracking

Gary Soneira, NOAA/AOML, Miami, FL

Real time XBT data received from VOS and research vessels first undergo automatic quality control tests. Those profiles that pass the tests are inserted onto the GTS. An operator reviews those that fail the tests to identify systematic problems. Once identified, the problems are remedied as quickly as possible to ensure a steady stream of high quality data. In addition, the complexity of the GTS demands data tracking to ensure that the data pipeline from sensor to user is continuous. This is accomplished through close cooperation between the data collectors (AOML) and the users (e.g., NCEP, Canadian MEDS, etc.). An informal association of international representatives monitor the quality of marine data routed on the GTS thereby improving the quality of the data. AOML is an active participant in this association.

Upper Ocean Temperature Delayed Mode Quality Control (QC)

Yeun-Ho C. Daneshzadeh
NOAA/AOML, Miami, FL

The objective of quality control of delayed mode data is to provide a CLIMATE QUALITY upper ocean temperature data set for use by operational agencies and researchers. The Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami is in responsible for scientific quality control of Expendable Bathythermograph (XBT) data set collected from either research vessels or voluntary observing ships (VOS). There were approximately 141,424 profiles quality controlled for the period 1990 through 1998 in the Atlantic Ocean. The 1999 data are being reviewed. Problems with the data have been identified and reported to NODC where corrections are being implemented. The procedures and schedules for delayed mode quality control have been developed under the auspices of the Global Temperature and Salinity Profile Project (GTSPP) and used during WOCE. In the future, there will be increased use of automatic quality control tests to reduce operator interaction, thereby reducing the delivery time of the data back to NODC.

Collection and Data Management of Thermosalinograph Observations

Steven Cook & Yeun-Ho C. Daneshzadeh
NOAA/AOML, Miami, FL

The collection of thermosalinograph (TSG) data by NOAA research vessels and merchant ships participating in the National Oceanic and Atmospheric Administration's NOAA) Voluntary Observing Ship (VOS) program began in the mid -1990's. The resulting data are used to satisfy NOAA’s climate mission. Specifically, the TSG data are needed in studies of the global meridional circulation and the role of the ocean in the global carbon dioxide budget. Recognizing the importance of the TSG observations, the international community has formed a data management team (GOSUD) to ensure uniformity in data collection, transmission, quality control, formats, meta-data, data access and data storage. AOML scientists are members of this team and are using the resulting procedures to develop a data management scheme for TSG observations collected for carbon dioxide studies. Automatic quality control tests have been developed and are being tested on delayed mode data from VOS. Within the next year, real time data will be transmitted from research vessels and VOS, quality controlled and distributed by the GTS. The data will also be available on the AOML web site.

Subtropical Atlantic Western Boundary Current Time Series

Molly Baringer, Chris Meinen, Silvia Garzoli, Elizabeth Johns,
Ryan Smith and Agusta Flosadottir

NOAA/OGP is supporting a project to continuously monitor two important components of the thermohaline circulation in the Subtropical North Atlantic with the ultimate goal of determining the state of the overturning circulation and providing a monitoring system for rapid climate change. The components include the northward flowing Florida Current and the southward flowing Deep Western Boundary Current. The Florida Current is the warm surface intensified flow that represents the bulk of what we call the upper limb of the thermohaline circulation in the subtropical Atlantic. As the Florida Current flows northward, where it become the Gulf Stream, it loses heat to the atmosphere until in the subpolar North Atlantic it becomes cold enough to sink towards the ocean bottom. This cold deep water then returns southward along the eastern continental slope as the Deep Western Boundary Current, completing the circuit of the overturning circulation. Components of the observing system include continuous real-time cable measurements of Gulf Stream transport, cable calibration cruises including eight small boat dropsonde cruises and quarterly Walton Smith CTD/LADCP cruises, annual full depth hydrographic CTD/LADCP cruises across the Deep Western Boundary Current and beginning in 2004 continuous moored measurements of the deep transports using PIES.

AOML Contribution to the Meridional Overturning Circulation and Heat-flux Array (MOCHA)

Molly Baringer[1], William Johns[2], Lisa Beal[2], Stuart Cunningham[3], Harry Bryden[3] and Jochem Marotzke[4]
[1]NOAA/AOML, [2]U. Miami, [3]Southampton Oc. Ctr., [4]Max Planck Inst
NOAA Collaborators: Chris Meinen and Silvia Garzoli, and Agusta Flosadottir

In March 2004, an international program deployed a system that will continuously observe the meridional mass and heat transport in the subtropical Atlantic. This system will document the variability of the subtropical Atlantic and its relationship to observed climate fluctuations, and the observations will help assess climate model predictions. MOCHA PIs include investigators from the Rapid Climate Change Program funded by the United Kingdom's Rapid Climate Change Program, National Science Foundation investigators at the University of Miami and NOAA/AOML. NOAA/AOML's contribution includes elements of the OGP funded Global Observing System. Of particular relevance for MOCHA investigators are (1) transport measurements within the Florida Straits including continuous cable measurements and small boat section estimates, (2) full-water-column hydrographic surveys of the Antilles and Deep Western Boundary Currents and the servicing of moorings, (3) deployment of inverted echo sounder moorings in the western boundary array, and (4) measurements of upper ocean temperature using expendable bathythermographs and profiling floats. This poster outlines the project goals and sampling array.

Meridional Heat Transport in the South Atlantic

Silvia L. Garzoli, Molly Baringer, Gustavo Goni and Qi Yao, NOAA/AOML

The South Atlantic Ocean is a major conduit for the warm upper layer water that flows northwards across the equator, compensating for the colder southward flowing North Atlantic Deep Water. This large-scale circulation is responsible for the northward heat flux through the South Atlantic and causes it to be unique among the oceans. Previous estimates of the heat transport in the South Atlantic in the 30° to 35°S band varies from negative values to more that 1 PW. This variability may be a consequence of the different pathways and of the different methods to calculate the heat transport, however natural variability in the heat transport, whether annual or interannual, cannot be ruled out using historical data. The upper branch of the MOC in the South Atlantic can be supplied by warm and saltier water that enters the South Atlantic via the Agulhas leakage (the warm route, Gordon, 1986) or by cold and fresh intermediate water that enters the South Atlantic via the Drake Passage (the cold route, Rintoul, 1991). According to Gordon (1992) the AAIW derived from the Drake Passage returns saltier and warmer via the Agulhas leakage after a loop in the Indian Ocean. It is not clear which of these two routes is the most important and or if there is some seasonal or interannual variability that may lead to the discrepancies in values. What it is clear is that in order to better understand the global ocean thermohaline circulation and its impact on climate it is necessary to reduce the heat flux uncertainty in the South Atlantic. Starting in 2002, and as part of the NOAA Global Ocean Observing System, a new XBT high-density line was started in the South Atlantic between Cape Town, South Africa and Buenos Aires, Argentina. The line was originally funded to be repeated twice a year but starting in 2004, occupations will be quarterly. The line was conceived to close the upper layer mass budget in the Atlantic and to estimate the variability of the upper limb of the MOC transport. Up to present 5 transects have been conducted, the latest in March/April 2004 is not yet available for this study. In this poster, preliminary calculations of the mass and heat transport along AX18 are presented.

Seasonal Variations of Surface Circulation in the Tropical Atlantic

Rick Lumpkin and Silvia L. Garzoli, NOAA/AOML, Miami, FL

A relatively recent dataset of satellite-tracked surface drifting buoy observations in the tropical Atlantic Ocean is analyzed using a new methodology. Features of the time-mean circulation and its seasonal variations are resolved at unprecedented scales, for both total and Ekman-removed velocities. The drifter observations reveal the branches of the South Equatorial Current (SEC), which form or merge with the North Brazil Current (NBC), correlated annual fluctuations in the strengths of the NBC retroflection, western North Equatorial Countercurrent (NECC) and SEC, and flow along the Guyana Coast, and strong semiannual variations in the equatorial band of the central basin. Conduits are traced which link seasonal variations of the equatorial current system's strength with the northern and southern hemisphere subtropical gyres. From these results, a new climatology of high-resolution monthly near-surface currents and concurrent sea surface temperature has been created.

US ARGO Data Assembly Center

C. Schmid[1], R. Sabina[1], Y-H. C. Daneshzadeh[1]
E. Forteza[2] and X. Xia[2]
[1]AOML/NOAA, [2]CIMAS/RSMAS

ARGO is an ongoing project that is conducted under the international cooperation of meteorological and oceanographic organizations, the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission of UNESCO (IOC), and other institutions. The goal of the project is to build a real-time, high-resolution monitoring system for the World Ocean, which uses sophisticated technologies, i.e. autonomous profiling floats, and satellite communication systems. During the period of the Argo project, approximately 3,000 floats will be deployed with an average spacing of about 300km. More than 1600 Argo floats have been deployed up to now. The data are collected, processed, quality controlled and distributed in real-time at several Data Assembly Centers (DAC) around the World. The US DAC is located at NOAA/AOML. This DAC collected 13131 profiles from February 2003 to February 2004.

The ocean monitoring system enables scientists to obtain the data almost instantaneously with high space-time resolution. The observations will greatly contribute to the study of interannual, decadal and inter-decadal variations of the Earth's climate system. It is expected that this will bring a substantial improvement in the reliability of long-term weather forecasts.

A Comparison of Temperature Profiles From Profiling Floats and XBTs

C. Schmid, NOAA/AOML, Miami, FL

In projects that jointly use profiles from profiling floats and XBTs, the consistency of the two data sets needs to be ensured to avoid errors that may lead to misinterpretation of the results. To achieve this both data sets have to pass through a series of quality control systems. The float profiles go through an automated QC according to ARGO standards. A similar test is applied to the XBT profiles. If a profile failed the automatic QC a visual QC is performed.

A comparison of nearby profiles is performed to detect sensor problems. For some, primarily pre-ARGO, floats a hysteresis of the pressure sensor needs to be taken into account. If such floats transmit the surface pressure at the end of the profile the correction of the pressure is relatively simple. Such corrections need to be verified on the basis of adjacent profiles from other floats and/or XBTs. The comparison with such buddies also allows the identification of significant differences of the temperatures that may be resolved by applying corrections to certain profiles.

New Estimates of the Heat Budget in the Tropical Atlantic, First Results

Schmid, Claudia[1] and Silvia L. Garzoli[1]
Rick Lumpkin[2] and Qi Yao[2]
[1]NOAA/AOML, [2]CIMAS, University Miami

A combination of data from XBTs, ARGO and pre-ARGO floats, and surface drifters is analyzed to study the heat budget of the tropical Atlantic. The annual cycle of the heat storage is derived by estimating the monthly means from data obtained in 1997-2003. The relative importance of the different heat budget terms for changes of the heat storage in the mixed layer are analyzed in three regions of the tropical Atlantic. Surfaces fluxes from NCEP are used to derive the net heat flux through the sea surface. The absorption of shortwave radiation in the mixed layer is computed on the basis of a model that uses chlorophyll A data from merged MODIS/SeaWifs fields to quantify the penetration of this radiation through the mixed layer. The role of the advection and upwelling are estimated from the velocity field derived from surface drifter trajectories. Regional differences of the annual cycle of the heat storage and heat fluxes will be addressed. Preliminary results from this study are presented. They are an improvement of previous results because the ARGO project provides data that not only improve the temperature data density but also provides salinity, which allows direct computation of the salinity dependent parameters.

A Major “DEFICIENCY” in NOAA Funding of GOOS: Lack of Adequate Support for “OPERATIONAL RESEARCH”

Robert L. Molinari, NOAA/AOML, Miami, FL

1) What is Operational Research?

Applied research directed at improving NOAA’s ability to meet the requirements of the climate mission of the agency through improved cost-effectiveness of existing networks (establishment of indices for climatically important signals, evaluation of model use of ocean data, evaluation of effect of new observing system on climate record, etc).

2) Examples of operational research:
   - Identification of climatically important oceanic signals and development of observing methods (e.g., long-term variability in transport of Florida Current)
   - Identification of indices for monitoring of thermohaline circulation
   - Effects of introduction of Argo floats on climate record
   - Analysis of forecast model rejects to determine if problem exist in observations and /or model analyses

3) Failure to support adequately operational research can result in:
   - Inefficient observing networks that fail to take full advantage of combining remote and in situ signals.
   - Introduction of ‘climate signals’ into historical record when new observing system implemented.
   - Failure to provide early warnings of climate change.
   - Inability to improve forecast models.

Intercomparison of Buoy-Mounted Anemometers

Michael J. McPhaden and H. Paul Freitag
Pacific Marine Environmental Laboratory, Seattle WA

Propeller-Vane anemometers have been the standard sensor for decades on many marine wind measurement systems. ATLAS moorings deployed within the Tropical Atmosphere Ocean (TAO) and Pilot Research Moored Array in the Tropical Atlantic (PIRATA) Arrays have used the R. M. Young model 05103 anemometer since the mooring system was first designed in the early 1980’s. In recent years several manufacturers have developed anemometers, which use ultrasonic technology. These sensors have no moving parts which provide the advantage of no mechanical wear, reduced potential for fouling in an unattended marine environment, and full 360º direction measurements. PMEL has deployed two of these newer sensors, the Vaisala Ultrasonic model WS425 and the Gill Wind Sonic collocated with a R. M. Young model 05103 on an ATLAS mooring in the tropical Pacific. Real-time daily mean wind components have been collected from this mooring for 6 months. All three sensors have worked relatively well, although the Vaisala sensor changed its units from m s^{-1} to kts shortly after deployment. Preliminary analysis indicates daily mean differences between the RMY and Gill sensors of -0.03 m s^{-1} in speed and 1.3 degrees in direction. Differences between the RMY and Vaisala sensors are 0.35 m s^{-1} and 2.4 degrees, respectively. The mooring will be recovered in May 2004, at which time higher temporal resolution (10-min) data will be available and additional analysis performed.

Climate Observations from the Peru-Chile Stratus Deck

Keir Colbo and Robert Weller
Woods Hole Oceanographic Institution, Woods Hole, MA

Initiated as part of the East Pacific Investigation of Climate (EPIC) in October 2000, a buoy with a suite of surface meteorological and upper ocean instrumentation was deployed at 20°S, 85°W in the center of the dense stratus cloud decks off of South America. The stratus clouds overlie an anomalously cool ocean, and are thought to play an important role in maintaining the equatorial asymmetry in wind and SST. Climate models have suggested that stratus clouds increase in response to increases in CO_2, and can thus act to counter increases in temperature in the subtropical ocean. This is also the source region of high salinity mode water that flows directly onto the equator and may play a role in modifying equatorial currents on inter-annual time scales.

Unfortunately, there is little observational basis for investigation of feedback mechanisms and the role of the eastern Pacific stratus decks in climate variability. The data has been used to understand the annual budgets of heat and salt in the upper ocean, which includes a large divergent eddy flux. A better understanding of the diurnal feedbacks between the ocean SST and the clouds is underway. The exchange mechanisms with the salinity minimum underlying the thermocline, and the subsequent modification of water masses is being quantified.

Meteorology and Air-Sea Fluxes from Ocean Reference Stations

Al Plueddemann and Bob Weller
Woods Hole Oceanographic Institution, Woods Hole, MA

Ocean reference stations are surface moorings deployed in key meteorological regimes around the world and equipped with sensors that sample meteorological and sea surface variables once per minute. At present, one station is operating under the stratus deck off of northern Chile (20°S, 85°W; see http://uop.whoi.edu/stratus), and a second in the trade wind region of the northwest tropical Atlantic (15°N, 51°W; http://uop.whoi.edu/ntas). These two stations are in their fourth year of operation (moorings are refurbished annually). A third station is in preparation for deployment north of Hawaii. The goal is to collect long time series of accurate surface meteorology, air-sea fluxes, and upper ocean variability and to use those data to quantify air-sea exchanges of heat, freshwater, and momentum, to describe the local oceanic response to atmospheric forcing, to motivate and guide improvement to numerical models and remote sensing products, and to provide anchor points for the development of new, basin scale fields of air-sea fluxes. The characteristics and performance of ocean reference stations are presented here, along with comparisons to other surface meteorology and flux products.

"Observations of Air-Sea Fluxes and the Surface of the Ocean"
"Implementation of High-Density Line in the Tropical Atlantic"

Robert Weller, David Hosom, Frank Bahr
Woods Hole Oceanographic Institution, Woods Hole, MA

Voluntary Observing Ships (VOS) use IMET technology on long routes that span the ocean basins and are collecting high quality surface meteorological data and fluxes to get spatial variability in these fields and in the departures of these fields from other representations of the same fields (models, satellites). These observations are essential to:

- Identify errors in existing climatological flux fields.
- Provide motivation for improvements to algorithms.
- Provide data needed to correct existing climatologies.
- Validate new model codes and remote sensing methods.

Continue operation on the Horizon Enterprise and Columbus Florida with six-month turnarounds (Pacific ships). Install a new system on the SeaLand Express and continue six-month turnarounds (Atlantic Ship). Install a new system on a 4th ship early in 2005 and continue six-month turnarounds. Continue cooperation with Southampton Oceanography Centre on CFD (computer flow dynamics) for data improvement. Note that 3 new AutoIMET systems were fabricated and the 3 ASIMET modules sets were converted to AutoIMET systems. These systems interface with the real time SEAS 2000 (Shipboard Environmental (Data) Acquisition System) for automated VOS reports. These 6 systems support the 4 VOS currently planned and permit repairs and re-calibration on a 6-month cycle.

The WHOI Analysis of Daily Air-Sea Heat Fluxes for the Atlantic Ocean

Lisan Yu, Robert A. Weller, and Xiangze Jin
Woods Hole Oceanographic Institution, Woods Hole, MA

High quality, time-dependent, and basin-to-global-scale air-sea heat fluxes are of great interest to climate research community for modeling and understanding coupled variability of the atmosphere-ocean system. This study is to show that we can produce a synthesized flux analysis with improved resolution and improved quality through combining satellite observations and numerical weather prediction model outputs and using in situ flux measurements as validation.

Daily air-sea heat fluxes for the Atlantic Ocean for the period 1988-1999 with 1°x1° resolution have been produced. The latent and sensible heat fluxes are developed from using improved surface meteorological fields through synthesis and the state-of-the-art COARE bulk flux algorithm 2.6a. Daily estimates of surface net shortwave and longwave radiation fields are derived from the International Satellite Cloud Climatology Project (ISCCP) dataset. The validation analysis shows that the daily surface heat flux estimates from the WHOI analysis agree well with buoy flux measurements, and they represent an improvement over the NCEP1 and NCEP2 fluxes. EOF analysis indicates that the net surface heat fluxes from WHOI analysis, NCEP1 and NCEP2 have a similar pattern for the first EOF mode but differ for the higher modes. The implications of data quality on the accuracy of EOF analysis are discussed.

Cloud Forcing of the Surface Energy Budget of the ITCZ/Cold Tongue Complex in the Tropical Eastern Pacific

[1]C. W. Fairall, [2]J. E. Hare, [1]T. Uttal, [3]Meghan Cronin and [3]Nick Bond
[1]NOAA Environmental Technology Laboratory, Boulder, CO
[2]Cooperative Institute for Research in Environmental Sciences, Boulder, CO
[3]NOAA Pacific Marine Environmental Laboratory, Seattle, WA

ETL and PMEL have cooperated on a ship-based cloud and flux measurement program to obtain statistics on key surface, MBL, and low-cloud macrophysical, microphysical, and radiative properties. The measurements were made as part of the PACS/EPIC monitoring program for the 95 W and 110 W TAO buoy lines in the tropical eastern Pacific. Our goal was to acquire a good sample of most of the relevant bulk variables that are commonly used in GCM parameterizations of these processes and to provide a more detailed context for measurements made on the TAO buoys over the annual cycle. These data are useful for coupled ocean-atmosphere modeling efforts, MBL/cloud modelers (both statistically, and for specific simulations) and to improve satellite retrieval methods for deducing MBL and cloud properties on larger spatial and temporal scales. In this paper we will report on results from the first three years of the project. Data from 7 cruises have been analyzed to reveal the latitudinal structure of surface forcing of the ocean and the role that clouds play in that structure. We will also contrast northern hemisphere spring and fall seasons. Cloud forcing of surface fluxes will be related to mean cloud fraction; cloud base heights and liquid water path will also be examined.

Quality of NOAA Vessel Underway Marine Meteorology

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The Center for Ocean-Atmospheric Prediction Studies has been receiving and processing rapidly-sampled meteorological data collected by automated weather systems (AWS) on the R/V *Ronald Brown* and *Ka'imimoana*. Data have been received since 1997 for the *Ronald Brown* and since 1999 for the *Ka'imimoana*. Both meteorological and navigation data undergo scientific quality control (QC) which includes both automated and visual QC procedures. Overall, the quality of the *Ka'imimoana* observations is slightly better than the *Ronald Brown*; however, large differences occur in the quality of the true winds, with the *Ka'imimoana* having considerably fewer QC flags than the *Ronald Brown*. An effort is currently underway at COAPS to determine some of the possible sources of error affecting the true winds from the *Ronald Brown* using NOAA/NDBC buoys, USF COMPS buoys, and SeaWinds scatterometer data.

Ocean Surface Data and Products from COAPS

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High quality observations and products near the surface of the ocean are essential to the understanding of air-sea interactions, for ocean and atmospheric modeling, and for climate applications. The Center for Ocean-Atmospheric Prediction Studies continues to be a leader in the evaluation of underway meteorological data and the production of wind and surface turbulent flux fields over the oceans. The in-situ 'FSU wind' fields for the tropical Pacific and Indian oceans continue to be widely used by both the research and operational communities. COAPS will improve upon the spatial and temporal resolution of these fields by combining satellite and in-situ observations into new products. Methods for estimating the uncertainty in these fields have been developed. In addition, COAPS is spearheading an initiative to ensure routine collection, quality control, and distribution of calibrated, underway, surface marine meteorological data obtained from automated weather stations on ships and moored platforms. COAPS freely distributes high-quality surface marine meteorological data, the FSU winds, and satellite products to any interested user through http://coaps.fsu.edu/.

The NOAA/NWS Marine Observation Network – A Climate Resource
Don T. Conlee, National Data Buoy Center

The National Weather Service's National Data Buoy Center (NDBC) operates the Marine Observation Network (MON). This network consists primarily of moored buoys and coastal marine (CMAN) stations around the continental U.S., Alaska and Hawaii. Many of the stations have a near-continuous record of up to 30 years of the primary meteorological parameters. Today's buoys contain proven instrumentation for a variety of meteorological and oceanographic parameters, many of which are in common with buoys designed specifically for climate purposes. NDBC has made a significant investment in sensor calibration and validation, having NIST-traceable primary standards for several parameters. Although the traditional customers, the National Weather Service Forecast Offices, Prediction Centers and mariners, demand real-time data reliability over high-precision measurement as a priority, NDBC buoys are able to deliver "climate quality" observations. NDBC sees no technical obstacles to designating a portion of the MON as Climate Reference Buoys, applying the "10 Climate Monitoring Principles" and adding parameters, which would be of dual interest to the climate change community and traditional operational customers.

CLIVAR/CO_2 Repeat Hydrography Program: Initial Results in the North Atlantic Ocean
R.A. Feely, C.L. Sabine, R. Wanninkhof, G.C. Johnson, J.L. Bullister, M. Baringer, C.W. Mordy, J.-Z. Zhang, M.F. Lamb, D. Greeley, F.J. Millero, A.G. Dickson

During the six-month period between June and December 2003, the first three cruises (A16N, A20N and A22N) of the CLIVAR/CO_2 Repeat Hydrography Program in the North Atlantic were successfully completed onboard the NOAA Ship Ronald Brown and R/V Knorr. These north-south cruises repeated oceanographic sections occupied in 1988, and again in 1993 for A16N; and 1997 for A20N, A22N. The results show significant changes in temperature, salinity, pCFC-12, AOU, and DIC over time, particularly in upper- and mid-thermocline waters of the North Atlantic. The DIC increase of about 5–22 µmol kg^{-1} at depths from about 100-800m north of ~ 20°N reflect the rapid uptake and transport of anthropogenic CO_2 in these waters. The DIC changes are consistent with the corresponding changes in AOU and other water mass properties, suggesting that decadal changes in local circulation, invasion of anthropogenic CO_2 into the interior North Atlantic, and/or changes in new production and remineralization of organic matter along the flow path are all possible causes for the observed variations.

Ocean Carbon Flux Maps
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One of the major long-term goals of the ocean carbon observation program is to deliver regional maps of air-sea CO_2 fluxes on seasonal timescales in order to better predict the near-term effect of changes in oceanic carbon uptake on climate and ocean ecology. A major observational component of this effort is to outfit research ships and volunteer observing ships (VOS) with automated analyzers to measure the partial pressure of CO_2 in surface ocean water and atmosphere. The poster will present the development of instrumentation for measuring pCO_2 in this effort, the initial results from the VOS lines, and describe the strategy to develop the seasonal flux maps through a combination of pCO_2 observations, modeling, algorithms development, and remote sensing. COSP sponsors the pCO_2 effort through grants to Nicolas Bates of the Bermuda

Biological Station for Research; Steven Cook of the NOAA/AOML GOOS center; Richard Feely of NOAA, PMEL; Frank Millero of RSMAS, U. Miami; Taro Takahashi of LDEO; and Rik Wanninkhof of NOAA/AOML.

OCO Moored pCO_2 Program

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The goal of this project is to evaluate the temporal variability in air-sea CO_2 fluxes by conducting high-resolution time-series measurements of atmospheric boundary layer and surface ocean CO_2 partial pressure (pCO_2). Although a reasonable picture of the large-scale spatial patterns in surface water pCO_2 and the air-sea CO_2 flux is starting to develop through the efforts of T. Takahashi and others (e.g. Takahashi et al., Deep-Sea Res. II, 49, 1601-1623, 2002), the temporal patterns are not well understood today. High-resolution data sets, like those that can be obtained from moorings, are ideal for evaluating coherent patterns of variability. Over the last 7 years, investigators at PMEL have worked very closely with the Monterey Bay Aquarium Research Institute (MBARI) to collect time series measurements of pCO_2 in the Equatorial Pacific. Our short-term objective is to expand the array to constrain the nature and timing of the El Niño CO_2 signal and the teleconnections into the North Pacific using the GEO reference sites. Ultimately, we seek to build upon the existing moored observations of pCO_2 in the Equatorial Pacific to form a moored pCO_2 network throughout the Pacific Ocean.

Annual Cycle of Inferred Equivalent Ocean Heat Content

Kevin E. Trenberth and David P. Stepaniak
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Net surface fluxes into or out of the ocean have been computed as residuals of the total heat budget of the Earth using top-of-atmosphere radiation and complete heat and energy budgets for the atmosphere. As the main ocean heat transports relate to the annual mean fluxes, the focus is on departures from the annual mean and the implied annual cycle in "equivalent ocean heat content". We use the term "equivalent" because it includes any annual cycle in ocean heat transports, but those effects are relatively small in most places, with the most notable exception in the tropics and especially from about 5 to 15°N, in association with the annual cycle in wind stress curl and North Equatorial Current. Elsewhere, good agreement exists with direct estimates of ocean heat content changes, suggesting that with modest improvements, divergent ocean heat transports may be deduced as a residual.

Global Freshwater Transports From Hydrographic Observations

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Meridional freshwater transports in the ocean are calculated from geostrophic velocities based on Reid (1994, 1997, 2003) and Ekman transports from near-surface climatologies. The overall freshwater transports and convergences agree reasonably well with previous estimates and with net evaporation/precipitation/runoff. The global total freshwater transports show an input of about 0.7 Sv from the Southern Ocean and 0.5 Sv from the Arctic Ocean into the lower latitudes, which thus have net evaporation. The freshwater transports are separated into contributions from the shallow, nearly horizontal ventilated circulation of the subtropical gyre thermoclines, and from intermediate and deepwater overturn. Because the major evaporation cells are centered in the subtropical gyres, the freshwater transports across the commonly used 24N and 30S sections are neither robustly poleward nor equatorward, but depend on the location of the sections relative to the basin evaporation maximum. NADW formation carries freshwater equatorward, resulting from conversion of saline surface waters into fresher Labrador Sea Water and Nordic Sea Overflow Water. The large deep overturning mass transport in the southern ocean due to formation of bottom waters from deepwaters carries only a small amount of freshwater poleward. Pacific and Indian deepwater freshwater transports are equatorward, associated with low latitude downward diffusion of higher salinity into the upwelled, southward-flowing deepwaters.

Recent Progress Towards Establishing an Arctic Ocean Observing System - A NOAA Contribution to the Study of Environmental Arctic Change (SEARCH)

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SEARCH is a coordinated, interagency program focused on understanding the full scope of changes taking place in the Arctic and to determine if the changes indicate the start of a major climate shift in this region. NOAA has initiated its contribution to the SEARCH program with seed activities that address high priority issues relating to the atmosphere and the cryosphere. One element of the NOAA SEARCH program is an Arctic Ocean Observing System. This poster describes the recent progress made in establishing components of this observing system, specifically the deployment of drifting ice mass balance mass (IMB) and ocean buoys and a seafloor mooring equipped with ice profiling sonar (IPS). We present examples of data collected from the drifting buoys, show the location of equipment deployed in 2003, the planned deployments for 2004, and describe other historic observations of changes in the thickness of the sea ice cover. Combined, these data are being used to monitor changes in the thickness of the Arctic sea ice cover and in near surface ocean characteristics.

Observing Sub-Polar Ocean Climate with Sea Gliders: Winter 2003-2004

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Global climate variability is affected by events at the rim of the Arctic. Ocean water masses are modified here, transports of liquid fresh-water, heat and ice are strong, decadal variability strong, and yet direct observations are sparse. A new NOAA program is aimed at observing this system with unprecedented coverage.

Two Seagliders were launched offshore of Nuuk, in west Greenland on 2 October 2003. These Seagliders patrol the Labrador Sea, profiling climate variables from surface to 1000m depth, reporting data home 3 times daily. Their course is controlled interactively via satellite. We say they can make "One-half knot on one-half a watt".

The Seagliders covered over 5000 km during winter 2003/4. The poster presents a first look at the data they produced. The continuing Seaglider program will contribute to the intensive monitoring of ocean climate change in the high-latitudes.

The Observing System Monitoring Center
A tool for monitoring and evaluation of the global ocean observing system

Steve Hankin, NOAA/PMEL, Seattle, WA

Understanding climate variability requires the development, maintenance and evaluation of a sustained global climate observing system. The purpose of the Observing System Monitoring Center (OSMC) is to provide a tool that will assist managers and scientists with monitoring the performance of the global in-situ ocean observing system, pin-pointing problems in real-time, and evaluating the adequacy of the observations in support of ocean/climate state estimation, forecasting and research.

The OSMC today offers two levels of access: an "executive" interface provides standardized visualizations -- overviews of in-situ ocean observations by platform type, location, time and variable. And a Live Access Server interface allows a user to probe more deeply through on-demand visualizations. The underlying metadata database spans the time period from September 1991 through April 2004, updated on a monthly basis.

The current OSMC system represents only the first steps towards its ultimate capabilities. In the future the OSMC will add additional variables, such as ocean carbon measurements; will offer real-time "drill down" capabilities, so observing system managers can assess the performance of individual instruments; and will become an integral component in the US Integrated Ocean Observing System (IOOS), which will provide complementary access to remote-sensed data, state estimation and forecast products. The OSMC is a joint effort of NOAA/PMEL and NOAA/NDBC.

Appendix C: List of Participants and Contact Information

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Appendix D: Climate Observing System Council (COSC)

The Climate Observing System Council reviews the Climate Observation Program's contribution to the international Global Climate Observing System to recommend effective ways for the Program to respond to the long-term observational needs of the Operational Forecast Centers, International Research Programs, and major Scientific Assessments. The Council meets at least annually and is comprised of members both internal and external to NOAA who individually offer their expert advice. The term of membership is two years with a renewal option for two additional terms.

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Appendix E: List of Acronyms

List of Acronyms

ADCP	Acoustic Doppler Current Profiler
AOML	Atlantic Oceanographic and Meteorological Laboratory
APDRC	Asia-Pacific Data Research Center
ARCs	Applied Research Centers
ARPEGE-CLIMAT	Climate Research Project on Small and Large Scales (France)
BMRC	Bureau of Meteorology Research Centre (Australia)
BoM	Bureau of Meteorology (Australia)
BPR	Bottom Pressure Recorder
BSH	Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency) (Germany)
C&GC	Climate and Global Change
CCRI	Climate Change Research Initiative
CCSP	Climate Change Science Program
CDC	Climate Diagnostics Center
CDP	Climate Data Portal
CFD	Computer Flow Dynamics
CICOR	Cooperative Institute for Climate and Ocean Research
CIMAS	Cooperative Institute for Marine and Atmospheric Studies
CIRES	Cooperative Institute for Research in Environmental Sciences
CLIPS	Climate Information and Prediction Services Project
CLIVAR	CLImate VARiability and Predictability
C-MAN	Coastal-Marine Automated Network
COLA	Center for Ocean, Land, and Atmosphere Studies
COAPS	Center for Ocean-Atmospheric Prediction Studies
COP	Climate Observation Program
CORC	Consortium on the Ocean's Role in Climate
COSC	Climate Observing System Council
COSP	Climate Observations and Services
CLIVAR	Climate Variability and Predictability Program
CPC	Climate Prediction Center
CPRDB	Comprehensive Pacific Raingauge Database
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTD	Conductivity, Temperature, Depth
DAC	Data Assembly Center
DART	Deep Ocean Assessment and Reporting of Tsunamis (Buoy)
DBCP	Data Buoy Cooperation Panel
DMC	Drought Monitoring Center
DODS	Distributed Ocean Data System
DWBC	Deep Western Boundary Current
ECCO	Estimating the Circulation and Climate of the Ocean
ECMWF	European Centre for Medium-Range Weather Forecasts
ENSO	El Niño-Southern Oscillation
EPIC	Eastern Pacific Investigation of Climate
ERS	Earth Remote-sensing Satellite
ETL	Environmental Technology Laboratory
EVAC	Environmental Verification and Analysis Center
FRX	Frequently Repeated XBT

FSU-COAPS	Florida State University Center for Ocean-Atmosphere Prediction Studies
GAINS	GLOSS Development in the Atlantic and Indian Oceans
GCC	Global Carbon Cycle
GCOS	Global Climate Observing System
GCTE	Global Change and Terrestrial Ecology Program
GCRMN	Global Coral Reef Monitoring Network
GDC	Global Drifter Center
GDP	Global Drifter Program
GEOSAT	Geodesy Satellite
GLOSS	Global Sea Level Observing System
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GPS@TG	Co-located GPS systems at tide gauge stations
GTS	Global Telecommunications System
GTSPP	Global Temperature-Salinity Profile Program
GUAN	Global Upper Air Network
HRX	High Resolution XBT
HURDAT	Atlantic Basin Hurricane Database
IAI	Inter-American Institute for Global Change Research
IOC	Intergovernmental Oceanographic Commission
IDOE	International Decade of Ocean Exploration
IES	Inverted Echo Sounder
IFREMER	Institut français de recherche pour l'exploitation de la mer (French Research Institute for Exploitation of the Sea) (France)
IMET	Improved METeorology
IOOS	Integrated Ocean Observing System
IPRC	International Pacific Research Center
IRD-Brest	L'Institut de recherché pour le developpement – Brest (France)
IRI	International Research Institute for Climate Prediction
ITCZ	Inter-Tropical Convergence Zone
IUGG	International Union of Geodesy and Geophysics
JAMSTEC	Japan Marine Science and Technology Center
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JIMAR	Joint Institute for Marine and Atmospheric Research, University of Hawaii
JIMO	Joint Institute for Marine Observations
JISAO	Joint Institute for the Study of the Atmosphere and Ocean
JMA	Japan Meteorological Agency
JTA	Joint Tariff Agreement
MEDS	Marine Environmental Data Services
MOC	Meridional Overturning Circulation
MOCHA	Meridional Overturning, Circulation and Heat Transport Array
NAO	North Atlantic Oscillation
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NDBC	National Data Buoy Center
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NEAR-GOOS	North-East Asian Regional GOOS

NERC	National Environmental Research Council
NESDIS	National Environmental Satellite, Data, & Information Service
NGO	Non-Governmental Organization
NIC	National Ice Center
NIH	National Institutes of Health
NMFS	National Marine Fisheries Service
NMHS	National Meteorological and Hydrological Services
NMRI	Naval Medical Research Institute
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NOPP	National Ocean Partnership Program
NORPAX	North Pacific Experiment
NOS	NOAA Ocean Service
NOSA	NOAA Observing System Architecture
NSF	National Science Foundation
NWS	National Weather Service
NWS-PR	National Weather Service Pacific Region
NVODS	National Virtual Ocean Data System
MON	NWS Marine Observation Network
OCO	Office of Climate Observation
OGP	Office of Global Programs
OMAO	Office of Marine and Aviation Operations
OOPC	Ocean Observations Panel for Climate
OSMC	Observing System Monitoring Center
PacificGOOS	Pacific Global Ocean Observing System
PACIS	Pan-American Climate Information System
PDO	Pacific Decadal Oscillation
PEAC	Pacific ENSO Applications Center
PHOD	Physical Oceanography Division
PIES	Pressure Gauge Equipped Inverted Echo Sounder
PMEL	Pacific Marine Environmental Laboratory
PNA	Pacific North America
PNNL	Pacific Northwest National Laboratory
RRP	ENSO Rapid Response Project
RVIB	Research Vessel / Ice Breaker
RSMAS	Rosenstiel School of Marine and Atmospheric Science
SCPP	Seasonal-to-Interannual Climate Prediction Program
SCMI	Southern California Marine Institute
SEACOOS	Southeast Atlantic Coastal Ocean Observing System
SEARCH	Study of Environmental Arctic Change
SEAS	Shipboard Environmental data Acquisition
SI	Seasonal-to-Interannual
SIO-ECPC	Scripps Institution of Oceanography-Experimental Climate Prediction Center
SLP-PAC	Sea Level Program in the Pacific
SOC	Southampton Oceanography Centre
SOOP	Ship-of-Opportunity Program
SOOPIP	Ship-of-Opportunity Implementation Panel
SOI	Southern Oscillation Index
SOT	Ship Observations Team
SPARCE	South Pacific Rainfall Climate Experiment

SRDC	Surface Reference Data Center
SSG	Scientific Steering Group
SSP	Sea Surface Pressure
SST	Sea Surface Temperature
START	Global Change System for Analysis, Research, and Training
SURFRAD	Surface Radiation Budget Network
TAO	Tropical Atmosphere Ocean Array
TOGA	Tropical Oceans-Global Atmosphere Program
TOPEX	Ocean TOPography Experiment
TRMM	Tropical Rainfall Measuring Mission
UHSLC	University of Hawaii Sea Level Center
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
UOTC	Upper Ocean Thermal Center
URI	University of Rhode Island
USIABP	U.S. Interagency Arctic Buoy Program
USGCRP	U.S. Global Change Research Program
UW	University of Washington
VOS	Voluntary Observing Ships
WCRP	World Climate Research Program
WDC-A	World Data Center-A for Oceanography
WHO	World Health Organization
WHOI	Wood's Hole Oceanographic Institution
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WWW	The World Weather Watch of WMO
XBT	Expendable Bathythermograph